AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 41 No. 548. **DECEMBER, 1951** PRICE : 3s. 6d.

AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

Consultant: W. L. FISHER, M.I.Mech.E., M.S.A.E.

Editorial Staff: R. T. CARR, M.Sc., A.M.Inst.C.E., A.M.I.Mech.E., J. B. DUNCAN, T. K. GARRETT, A.M.I.Mech.E., A.F.R. Ae.S., F. C. SHEFFIELD

Publishers: ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1:
Telegrams: Sliderule, Sedist London **Telephone: Waterloo 3333 (60 lines)**

COVENTRY:	BIRMINGHAM, 2:	MANCHESTER, 3:	GLASGOW, C.2:
8-10 CORPORATION ST.	KING EDWARD HOUSE, NEW ST.	260, DEANSGATE	26B, RENFIELD ST
Telegrams: Autocar, Coventry	*Telegrams:* Autopress, Birmingham	*Telegrams:* Iliffe, Manchester	*Telegrams:* Iliffe, Glasgow
Telephone: Coventry 5210	*Telephone:* Midland 7191-7	*Telephone:* Blackfriars 4412	*Telephone:* Central 1265-1266 (2 lines)

PUBLISHED MONTHLY—SECOND THURSDAY

Annual Subscription: Home and Overseas £2 11s. 6d., including the Special Number; Canada $7.50; U.S.A. $8.00

VOL. XLI No. 548 **DECEMBER 1951** **PRICE 3s. 6d.**

Tyre and Spring

A HIGH standard of riding comfort has been established by the modern automobile as the result of greatly improved springing and the use of tyres of lower working pressures and correspondingly more flexible carcases. Suspension developments seem the more spectacular because of their complexity. Apart from the practical elimination of gyroscopic effects as "disturbers of the peace" of the front wheels, independent suspension has been associated with markedly increased deflection and, in general, with great reduction in static friction by the substitution of helical or torsion springs for the customary leaf spring as a supporting means.

Again, the wide use of rubber in front suspension joints has assisted in suppressing rumbles and other noises which were liable to become serious defects in many vehicles of "stressed-skin" integral construction that lacked the local stiffness and mass of a separate chassis frame.

With the improvement in comfort arising from the reduction of pitching, these observations are not concerned. The intention, at the moment, is to make comparison between the respective contributions of the tyre and of the spring in reducing the discomfort produced by small road irregularities. In passing, it may be admitted that the increased front-spring deflections, now so widely adopted as a cure for pitching troubles, have had some effect in absorbing the minor bumps, joggles and noises for which a bad road surface is responsible. These remarks will also be confined to the front end of the vehicle, since it is there that suspension changes have been more radical and more improvement is to be expected. The rear suspension of many modern cars shows little change except for moderate increases in deflection of the usual leaf springs, the use of rubber in shackles and anchorages and the fitting of hydraulic dampers of greater, and more sustained, efficiency.

Increased Deflection

When it is recollected that many modern automobiles have front suspensions with spring deflections of as much as nine inches while the softest tyres deform only about one inch under static load, one might be excused for thinking that the tyre did ten per cent of the work and the spring the remainder. The fallacy of this assumption can be proved in a few minutes by inflating the tyres to, say, fifty per cent above normal pressure and driving over a bad road. Though the overall deflection of the combined suspension system is thereby reduced by only about three-eighths of an inch, or four per cent, the falling-off in comfort is generally found to be most marked. Quite apart from its effects on steering behaviour, some of which may be beneficial and others not so, an increase in tyre pressure by the amount suggested can often make a vehicle definitely uncomfortable.

At this point a cynical designer might well say that "it served you right" for upsetting the carefully calculated balance of slip-angles, precession-torque and other factors and interfering with the most vital part of the whole suspension, the tyre. To that the equally cynical rejoinder could be made that it is a pity all the complicated mass of independent front suspension gear is still at the mercy of the tyre, and that we must, perforce, accept heavy steering, imprecise handling at speed, reduced tyre life and increased rolling resistance as the price of comfort.

Cornering Power

Not the least disconcerting feature of the present-day domination of the vehicle by the tyre is the difference in handling often to be found when changing from one make of tyre to another with different cord-angles, carcase stiffness, tread-pattern and the like. The cornering power of the modern tyre is not conspicuously good, and varies too much with change of load and tyre pressure. It provokes nostalgic memories of the bad old days when tyres were stiff and rattled a car to pieces, but did place it where it was intended with the minimum of effort.

Apart from the mysterious improvement in comfort it affords, probably the only thing to be put to the credit of the low-pressure tyre is its better performance on soft sand. Against this it may be alleged that most of the advantage is now lost by the "front-heavy" weight distribution of the modern car which, under some circumstances, provides a quite inadequate weight for driving wheel adhesion and, coupled with the small wheels now becoming common, leave the car stuck deeper in the sand or mud than would an old-fashioned vehicle with large, stiff tyres and plenty of rear-axle weight.

A further criticism of the tyre is that its indifferent cornering power is responsible for some of the anti-rolling bars that have been mounted at the front end. These were fitted, not because the front suspension needed stiffening in rolling, but because it was necessary to overload the outside front tyre to make the car handle properly. In other words the suspension designer has to see a large part

of the independent deflection of nine inches he provided at some cost, cancelled out by an anti-rolling bar which, in a sense, the tyre makers have forced on him.

Having thus abused the tyre, it must be admitted that the tyre makers are fully aware of these shortcomings and are striving to effect an improvement. Much work is being done on the Continent, it is understood, towards developing a breaker-strip added to the tyre carcase and having diagonal stiffeners which, by preventing local lateral yielding of the tread, double the cornering power, or halve the slip-angle which comes to the same thing. Unfortunately, this ingenious modification is found to reduce appreciably the "enveloping power" of the tread, resulting in increased momentary loads, vertical and lateral, when striking a small irregularity in the road surface.

While the suggestion is that the tyre is too accommodating, to some extent wearing itself out prematurely by good works, it must be granted that it puts up with errors of steering geometry in a manner that a stiffer and more robust wheel-cushioning would not. When, for example, the slip angle on a sharp curve is of the order of ten degrees, it is obvious that a momentary steering error of few degrees, as between the heavily loaded outside wheel and the lightly loaded inside one, will have no appreciable effect on tread wear. Nor will it affect the handling of the car to any serious extent. Supporting this assumption is the fact that one well-known car, having notably good handling qualities at all speeds, has steering arms approximately parallel and therefore lacks the Ackermann correction that is generally assumed to be essential.

Track Variation

Again, momentary track variations under suspension deflections appear to have little detrimental effect on tyres. While this is partly due to the low periodicity of modern front suspensions, which spreads the track change over a greater length of road, relatively good tyre mileages are obtained on cars with fairly stiff front springing and overall track variation of the order of four inches.

Laying no claim to omniscience, the earlier reference to the mysterious improvement in comfort afforded by the tyre may be allowed; doubtless there are many to whom the tyre has no mysteries. Nevertheless, it would appear that the difference between a tyre and a spring, apart from the fact that the carcase, with its large area of contact, has an averaging action, is that the tyre absorbs or modifies the lateral components of the forces acting between the road and the wheel. The spring, moving in a vertical direction only cannot do this in its function as the medium connecting the wheel with the car.

That is why the "rubberization" of independent front suspension is of value, since it provides both fore-and-aft as well as sideways flexibility in the connection between the wheel and the car. If comfort is to be maintained, however, in conjunction with tyres giving improved cornering power, it would seem that the lateral flexibility should not be provided by promiscuous sponginess in suspension details. Some of these should, preferably, be more rigid in their functions as part of the steering mechanism while others may introduce undesirable brake-shudder in their capacity as fore-and-aft wheel locations.

Lateral Flexibility

It would seem more logical to design the whole independent front suspension assembly with rigid bearings throughout and to mount with it, on its cross-member, the steering box. The steering linkage should be as rigid as reasonably possible and, to stop wheel-fight, incorporate a hydraulic damper having passages sufficiently large as not to offer appreciable resistance to steady steering movement. This complete cross-member could then be attached to the car by rubber mountings, probably of the horizontal sandwich type, which might have considerable lateral flexibility and as much fore-and-aft flexibility, possibly damped, as was consistent with absence of brake shudder. Very little vertical flexibility should be necessary and brake torque could well be taken by appropriately spaced pairs of sandwich mountings.

The steering mechanism would be far more rigid than is at present customary, but rubber couplings could be inserted in the connections to the separately-mounted steering wheel to give an overall "sponginess" between steering wheel rim and road wheel rather less than that at present given by the sum of the deflections of levers. The new Vauxhall cars shown at Earls Court go some distance in the direction indicated, but something more drastic than this is visualized.

It might then be found possible to equip the vehicle with tyres in which high cornering power, low rolling resistance and long life were the dominating features of design. The car manufacturer would be expected to take care of more of the suspension problem than has been customary in the past. So long as the tyres deflect sufficiently to keep the treads in contact with the road surface under all but the most exceptional circumstances, the policy suggested should result in more economical motoring, in terms of fuel and tyre costs per mile, without any appreciable sacrifice of comfort. Road handling at speed should be better and more consistent, while parking would be possible to the aged and infirm, who form an increasing proportion of our population, without the additional complication of power-assisted steering systems.

CONTENTS OF THIS ISSUE

THE PARIS SALON

Intensive Development of Small Cars. Marked Progress in Weight Reduction

ALTHOUGH a general tendency to restrain new designs and to develop on orthodox lines was evident this year, as in 1950, a close examination revealed a number of interesting innovations. Exhibitors at the Paris Salon, unlike their counterparts at the British Motor Show at Earls Court, are allowed to display prototypes. This may be criticized on the ground that the exhibits should be confined to those models that may be purchased by members of the public. Disregarding that argument, however, it is stimulating to see the direction in which the designer is looking for future development. Also, comments and criticizm expressed by the would-be purchaser, serve as an indication of the reception that the production version of the prototype is likely to receive. In the interests of economy, engine capacity has been reduced to the barest minimum. In fact, engines of 175 c.c. capacity, small even by motor cycle standards, are used. Of necessity, such cars must be of very light construction and this has, in some cases, dictated the body styles.

It is possible to purchase a car having a rating of not more than 4 h.p. that has space for four persons or, alternatively, two seats and a relatively higher performance.

Of the expensive or luxury cars exhibited the accent generally is on high performance rather than luxurious passenger accommodation. Exceptions are the Rolls-Royce and the large American cars such as the Cadillac which, in spite of the fact that it will comfortably accommodate six people, is in the 90 m.p.h. performance class.

Generally, among the small cars exhibited, the complete engine and transmission unit is either at the front or the rear of the vehicle. In other words, a forward-mounted engine and front-wheel drive, or a rear engine and rear-wheel drive. Examples of both types are in production by two of France's largest manufacturers. With the front-engined small cars the air-cooled, horizontally-opposed, twin-cylinder engine is extremely popular: this arrangement facilitates air cooling and also results in a low overall engine height which in turn allows a correspondingly low bonnet line. It is used on cars of varying performance, including the Citroen, Panhard, and Nardi.

Rated at 2 h.p., the Citroen, in spite of its somewhat austere external appearance, is essentially a practical vehicle and is becoming increasingly popular. With a bore and stroke of 62 mm, giving a capacity of 375 c.c., and having a compression ratio of 6·2 : 1, it develops 9 b.h.p. at 3,800 r.p.m. The engine is mounted in front of, and in unit with, the four-speed and reverse gearbox and differential; the final drive being by two shafts to the front wheels. Unlike the larger front-wheel-drive models produced by the same Company, the front brakes are mounted inboard on each side of the transmission casing. Air cooling is provided by a single fan and ducts which convey the air over the finned cylinders. A simple form of interior body heating is achieved by arranging ducts to convey the heated air to the interior of the body. Suitable butterfly valves are fitted forward of the toe-board to regulate the temperature.

Simca Sport fixed head coupé

Although the rear-engined, 4 h.p. Renault was not received without some adverse comment when it first appeared, in the hands of the public it is very popular. However, from the fact that there is need for a large differential in tyre pressures, front and rear, coupled with the use of centralizing springs on the steering unit, it would seem to indicate that future development in the direction of increased performance would be limited. This may not be detrimental, as in the past there has been a tendency for miniature cars to "grow up" through the years and in so doing to depart from the original conception of a light, economical vehicle.

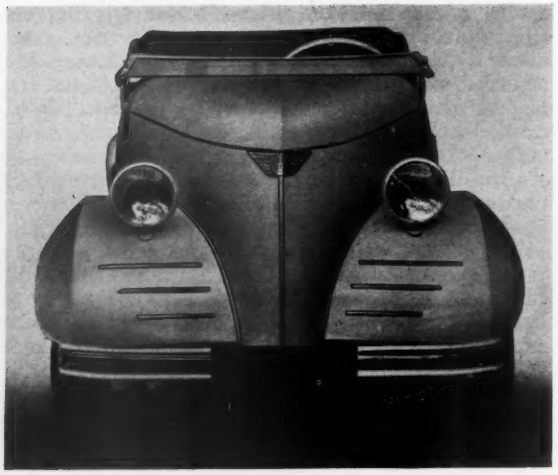
Performance is not necessarily sacrificed when a small engine is used, but some of the relatively high performance small cars are expensive. For example, the Panhard saloon has had many successes in competition but it costs more than the 15 h.p. Citroen. However, in a country where fuel is expensive, first cost may not be the primary consideration of an owner whose annual mileage is large. Three engine sizes are available, and in each case similar basic components are used. With a stroke of 75 mm, the bore is varied from 72 mm to 85 mm to produce the 3, 4 or 5 h.p. power units. The smallest, with a capacity of 610 c.c., develops 28 b.h.p. while the largest produces 40 b.h.p. from 850 c.c. capacity. The unusual arrangement of torsion-bar springs is still employed to seat the overhead valves.

As is the case with the Citroen, front-wheel drive is used, but the front suspension is independent by twin leaf springs. Steering is by rack

Duriez body on a 4 h.p. Renault

D.B. Panhard

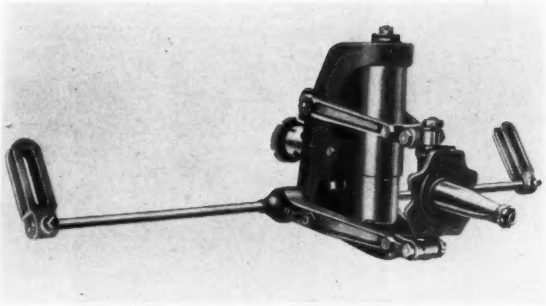
Rosengart saloon



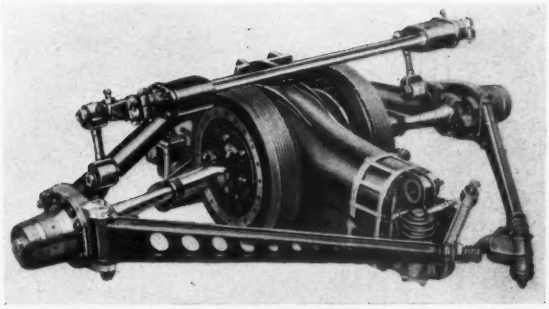
Rolux minicar

Bimobile two-seater

Ford Cométe saloon



Pegaso torsion bar front suspension

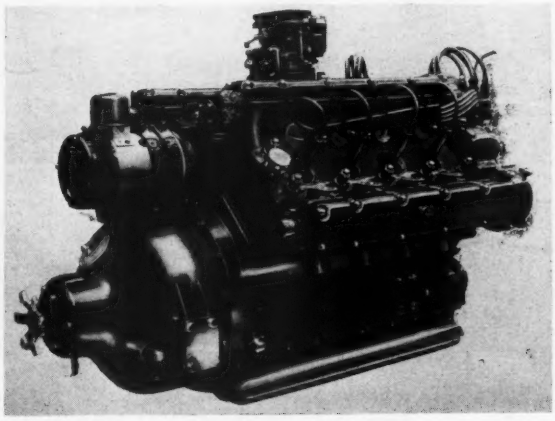


Pegaso rear suspension

and pinion. The rear suspension is by means of a centrally pivoted, bent beam and two trailing links which are coupled to transverse torsion bars. A form of air-conditioning is used similar to the Citroen but whereas that collects air from around the cylinder barrels, the Panhard system employs a duct and jacket enclosing the exhaust pipes. Although such an arrangement is effective it may be dangerous in the event of leakage, as exhaust fumes could be conveyed into the interior of the cars.

Apart from the various saloon, cabriolet, and Dyna-Junior models produced by the Company, the Panhard chassis forms a basis for several specialist bodies.

Another example of the relatively high-priced small cars is the Nardi; a chassis that, together with a well-balanced, two-seater saloon body aroused very favourable comment. Although to date only about sixty of these machines have been produced, the chassis is very well made. The construction is simple, consisting of a welded-up structure of straight small diameter, steel tubes having a thickness of 1·5 mm. Fiat components are used for the gearbox, the rear axle and the steering, while the Company produce their own 750 c.c., air-cooled, horizontally-opposed, twin-cylinder engine. This is of the usual push-rod operated overhead valve design but twin carburettors are used. They are mounted directly on the cylinder heads, facing forwards, and consequently the exhaust pipes extend from the rear. Such an arrangement seems peculiar on an air-cooled engine, as the hottest part of the cylinder head and the exhaust pipe are shielded from direct draught.

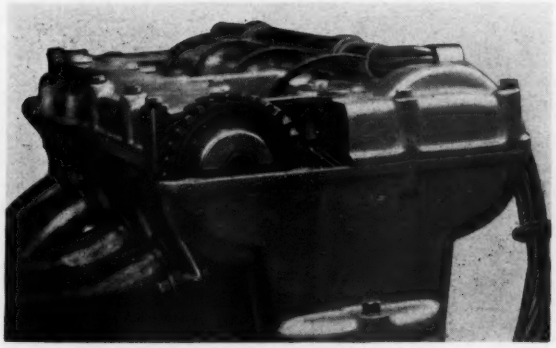


Pegaso V-eight engine

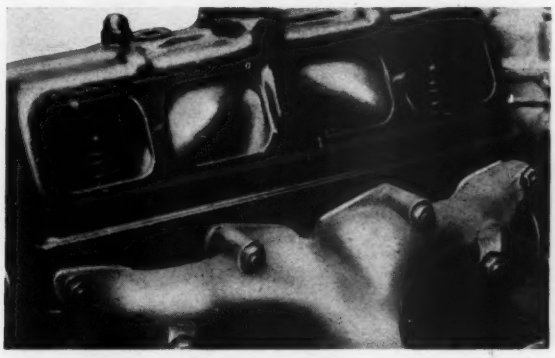
It is interesting to note that in this instance a conventional arrangement of front-mounted engine with rear-wheel drive is used, necessitating a large tunnel running through the body. Independent front suspension is by wishbones and a leaf spring, while at the rear, forward-facing quarter-elliptic springs are used in conjunction with radius rods to take torque reaction. Telescopic shock absorbers are inclined inwards at the front and vertically mounted at the rear of the chassis.

The steering is by a Fiat box and a two-piece track rod. This arrangement of track rods is also used by Maserati, among others, but it is a system that does not usually give such accurate wheel control as a three-piece track rod, or a rack and pinion arrangement, unless only a limited wheel movement is allowed. Everything on the chassis has been designed to save weight. Components such as the road wheels and the petrol tank are produced from light alloy, and the external rim of the steering wheel is formed out of bonded cork. These and other weight-saving measures result in a dry weight of approximately 460 lb for the complete chassis and it is claimed that a speed of 100 m.p.h. is possible when fitted with a two-seater body.

Attracting the greatest amount of



Salmson Randonnée camshaft drive



Enclosed inlet manifold on Borgward Hansa 1500

Ferrari type 212 fixed head coupé

Goliath saloon

Kaiser "Henry J" saloon

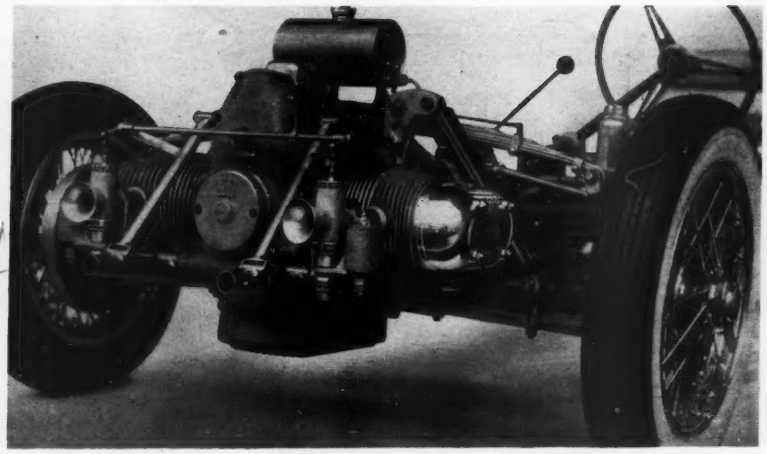
Nardi 750 c.c. coupé sport

attention throughout the Show was the experimental Le Sabre, built by General Motors. Intended as a mobile test rig on which to prove a number of components prior to their adoption on production models, this vehicle literally bristles with new ideas. The engine is a 90 deg V-type, eight cylinder unit having a 10 : 1 compression ratio and is stated to produce 300 b.h.p. when supercharged. The main castings are made of light alloy, steel sleeves being fitted into the bores. With a bore and stroke of 82·6 mm the engine has a swept capacity of 3·523 litres.

Aircraft type carburettors meter both petrol and methanol from tanks located in the rear wings. For normal running petrol only is used, but at large throttle openings or speeds over 78 m.p.h. methanol is also employed. The overhead valves are operated by rockers and pushrods from a single camshaft located above the crankshaft, but on this engine the push rods operating the exhaust valves are at a wide angle and pass between the cylinder bores.

Transmission is by a modified form of the Dynaflow unit, coupled to hypoid final drive; the complete unit having a three-point mounting. A De Dion-type rear axle is used and the brakes are mounted inboard on the rear drive unit as, also, are the dynamo and starter motor. Consequently, the engine is started through the propeller shaft. No flywheel is fitted directly behind the engine, but in its place is a brass damping disc.

Suspension at the front is by means of wishbones and bonded rubber bushes, and at the rear by a transverse leaf spring consisting of a single blade. Steering is effected by a three-piece track rod with two slave levers; the drop arm being connected to one of the levers by a link rod. The brakes



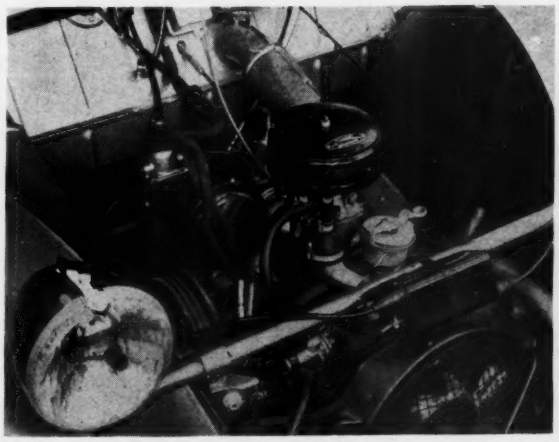
Nardi tubular chassis

are interesting in that four shoes are used per drum. These are arranged in pairs side-by-side and, to obviate squeal and provide a self-cleaning action, the lining faces are relieved at intervals round the periphery.

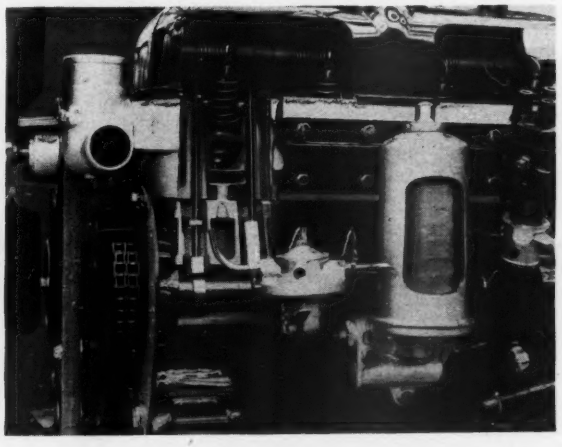
The body style can be described as modernistic, even by American standards. At the front end what appears to be a top air intake—and is probably intended to give the impression that the vehicle is jet-propelled—is, in fact, a cover for the head lamps which automatically swing into position when the lights are switched on. The same jet styling influences the treatment of the rear of the car, where the stop lamp is surrounded by reflectors which illuminate a circle, approximately a foot in diameter, when the brakes are applied.

To save weight, light alloy is used extensively on this vehicle but, instead of sheet aluminium, magnesium castings are used for a number of the body panels. This construction would, no doubt, necessitate the complete replacement of all damaged panels in the event of accident. However, it would simplify production inasmuch as all stiffening ribs and lugs for attachment points can be formed integrally. Furthermore, the resulting structure is claimed to be stiffer than its built-up counterpart would be. Instead of being completely detachable, the panels enclosing the rear wheels are hinged and spring-loaded so that they will remain in the open or closed position; an arrangement that enables a wheel change of tyre-pressure check to be carried out more speedily than is the case when the cover has to be completely removed and replaced.

The electrical system is extremely elaborate, both low tension and 120-volt systems being used; the high voltage in conjunction with Neon black-light instrument illumination. No fuses are used in the circuits but in their place fifty-eight relays are employed with the aim to make the car virtually fool-proof. For example,



2 h.p. Citroen engine

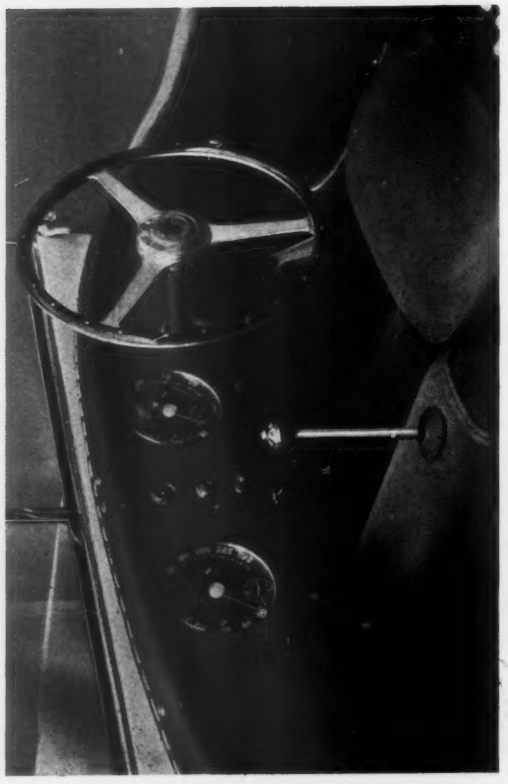


Peugeot 203 engine

D.B. Panhard dash

Simca Sport facia

Le Sabre facia



Ferrari 212 Sport dash

if the ignition key is removed from the facia panel the doors may be opened from inside but when they are closed they become automatically locked and can only be opened from the outside by means of the door key. Again, if the car is left with the hood down, any rain falling on an exposed grid placed between the seats will close a circuit to operate a relay and automatically raise the hood.

In spite of the peculiar appearance of the windscreen, the general driving position and exterior view is very good. There is ample seating adjustment and driving comfort is further considered by means of radiant heat arranged to come through the seat cushion and squab. Fitted between the seats and on top of the propeller shaft tunnel is the radio control unit which has an automatic station selector to cut in to the "strongest" station.

Bugatti type 101 saloon

Talbot Lago Record

Exhibiting in the commercial field last year, Pegaso has now entered the passenger car market with a range of models on a very advanced chassis. This car is, produced at Barcelona in the works formerly occupied by Hispano Suiza and was designed by Señor Rickart who has been connected with the design of previous Alfa-Romeo cars. The engine is a 90 deg V-type, eight cylinder unit with a bore and stroke of 75 mm and 70 mm respectively, giving a capacity of 2,474 c.c., and with a compression ratio of 8 : 1 produces approximately 140 b.h.p. at 6,000 r.p.m.

Inclined overhead valves are directly operated by four overhead camshafts which are driven by single helical gears. Alternative types of ignition are available; the car shown had two ignition distributors mounted on the front of the engine. The dynamo is belt-driven from a pulley attached to the rear end of the inner left-hand camshaft. One dual downdraught carburettor is located between the two banks of cylinders. The exhaust manifolds are located on the outsides of the cylinder banks.

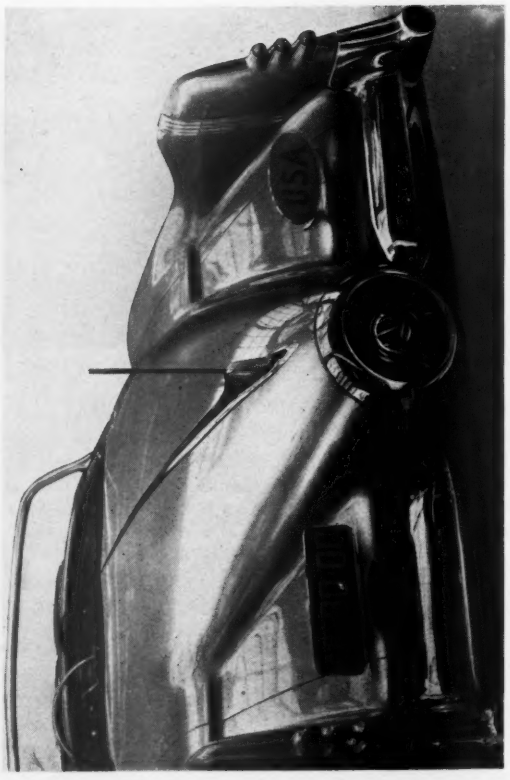
The transmission is of interest in that it follows an idea used by Lancia on their Aurelia model and consists of mounting the five-speed gearbox in unit with the De Dion-type rear axle and the rear brakes. Rear suspension is by transverse torsion bars controlled by hydraulic shock absorbers. The front suspension is unusual in that it embodies two torsion bars per wheel. One bar is attached to each arm of the lower wishbones and a large hydraulic damper is housed in a position normally occupied by the coil spring in a long and short wishbone arrangement.

The body styling shows an Italian influence, resulting in a very attractive vehicle with a minimum of exterior ornamentation. In place of an air intake, often to be found in the centre of the bonnet on high performance cars, the Pegaso has a depression towards the rear end, with an opening, rather like a letterbox, to allow hot air to escape. This aperture is also functional in that the warmed air will tend to prevent the formation of ice on the windscreen in cold weather. To ensure an adequate supply of cool air to the carburettor, a duct built into the bonnet top extends forward to a point just behind the radiator grille and seals on to the carburettor intake by means of a sponge-rubber washer.

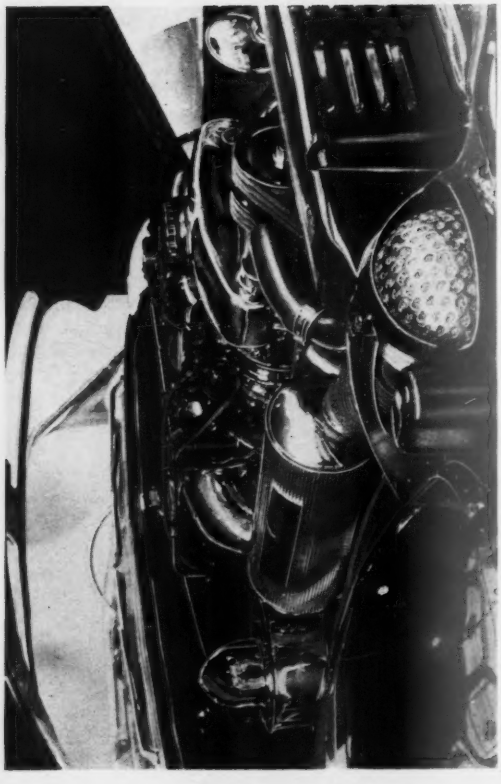
The Bugatti type 110 chassis, with open or closed bodywork, was one of the most expensive French cars exhibited. Despite it being in the 3,000,000 franc class it retains such items as a beam front axle with half-elliptic springs. The engine, of which two versions are available, is in fact a revival of the pre-war type 57 unit. In its normally aspirated form the

Facel-Metallon coachwork on Bentley chassis

Renault Frégate engine compartment



Le Sabre rear view



Le Sabre engine compartment

Le Sabre rear wheel cover

engine develops 150 b.h.p. at 5,500 r.p.m., while the supercharged version produces 210 b.h.p. at the same speed. This, it is claimed, enables car speeds of 93 and 110 m.p.h. respectively. Transmission is by means of a five-speed gearbox, which may be of synchromesh type or a Cotal unit. The chassis layout is not new.

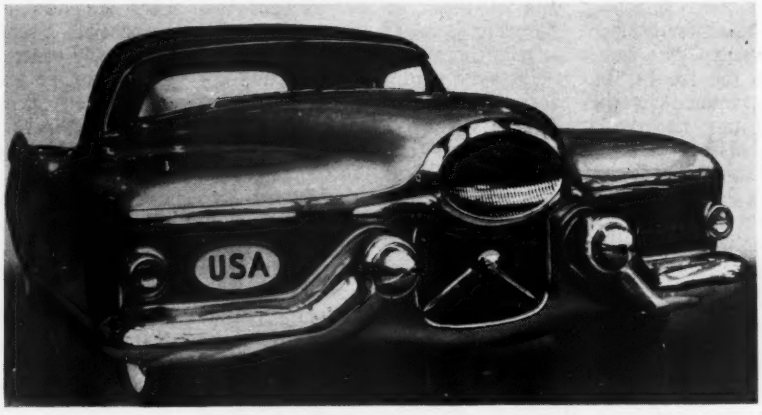
A new model from the Salmson Company is the Randonnée and in this vehicle the designers have made a determined effort to reduce weight on some of the major components. Rated as 13 h.p., the four-cylinder engine has a bore and stroke of 82 mm and 105 mm, giving a capacity of 2·2 litres. It develops approximately 80 b.h.p. at 5,000 r.p.m. and in spite of its relatively long stroke, is designed to give a good performance.

Cast in light alloy, the cylinder block is fitted with nitrided steel liners. The cylinder head, also in light alloy, houses the inclined valves and twin overhead camshafts. The drive to the camshafts is by means of a vertical shaft driven from the rear end of the crankshaft, which engages spiral gears on the ends of the two camshafts. Although of apparently large proportions it should be noted that these gears are made of moulded Celeron.

Unlike some twin overhead camshaft engines the valves must be retimed after each removal of the cylinder head. To facilitate this operation the timing wheels are serrated to give fine adjustment. The use of light alloy has been extended to the connecting rods, which have no inserted bearings and run directly on the nitrided crankshaft and on the gudgeon pin. As a result of this type of bearing arrangement the manufacturers found it necessary to incorporate a magnetic oil filter. The mixture is supplied to the engine by a single horizontal Zenith carburettor.

It is interesting to note that the use of light alloys has, it is claimed, reduced the engine weight from 264 lb in 1950 to 141 lb for the new engine of the same capacity. The chassis is orthodox in that the front suspension is independent, with wishbones and torsion bars, while the rear suspension is by half-elliptic springs with a hypoid final drive. Rack and pinion steering is used.

Pegaso saloon



Le Sabre experimental car

One of the exhibitors from Germany was Borgward, showing both commerical vehicles and the Hansa 1500 range of private cars. Rated as 9 h.p. the 1½-litre engine has a bore and stroke of 72 mm and 92 mm respectively and can be supplied in two versions. One has a compression ratio of 6·3 : 1 and develops 52 b.h.p. at 4,000 r.p.m. while the other, with a compression ratio of 7·2 : 1 and fitted with two carburettors, produces 66 b.h.p. at 4,400 r.p.m.

In the case of the high-compression engine, an alloy head with steel valve seatings is used. The engine is of orthodox construction except for the arrangement of the inlet manifold which is fitted on top of the cylinder head and is enclosed by the rocker box. A detachable cover is fitted on each side of the rocker box, to enable tappet adjustments to be effected without disturbing the carburettor. The manifold casting is extended down to the cylinder head at a point below the carburettor riser to form a hot-spot, which is maintained at 80 deg C (176 deg F).

Transmission is by a single-plate clutch and a four-speed gearbox which has synchromesh on third and top gear only. The chassis consists of a main cruciform member having a

Talbot Lago Grand Sport with Farina coachwork

central portion of rectangular box section, through which is passed the propeller shaft. The rectangular floor pressing is attached to the lower side of the cruciform member and although this produces a low floor level it also means that a central tunnel of abnormally large proportions runs through the centre of the car. This feature would make travel for a third person in the front seat rather uncomfortable.

Suspension is independent all round; by wishbones and a single leaf spring at the front, and by swing axles, transverse leaf springs and radius rods at the rear. A simple form of steering-column gear change mechanism is used. The operating link extends radially outwards from the steering column and down to the gearbox through the large tunnel previously mentioned. Such an arrangement avoids the necessity of passing the complete mechanism through the main bulkhead and then back by a system of levers to the gearbox striking mechanism.

To eliminate the need for electric fans in the heater system, two large ducts are built into the front wing pressings, and air rammed in the ducts is directed into the body interior. Towards the front of these ducts are small additional radiators connected by pipes to the main engine radiator. When the water is allowed to circulate through the heater radiators it warms the air in the body interior. To de-mist the windscreen small branch pipes are tapped from the main air ducts.

Also from Germany, Mercedes Benz exhibited the type 300 chassis, a 170 diesel-engined car, and the type 300S. The power units are similar to those exhibited previous by this year. The six-cylinder petrol engine has a bore and stroke of 85 mm and 88 mm respectively, giving a capacity of 2,996 c.c. Type 300, running on a 6·5 : 1 compression ratio, develops 115 b.h.p. at 4,800 r.p.m. while, it is claimed, type 300S having a 7·5 : 1 compression ratio and furnished with three carburettors, develops 150 b.h.p. at 5,800 r.p.m.

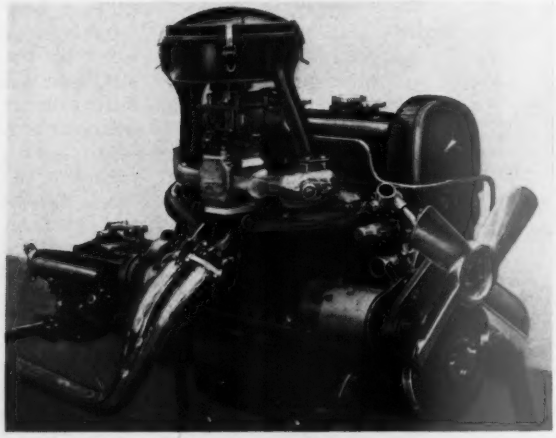
Tatraplan rear-engined saloon

Thermostatically controlled hot-spot inlet manifolds are used and in the case of the type 300 engines two complete sets of flap valves, bi-metallic thermostat springs and balance weights are used. To ensure uniform operation, a small rod couples the two balance weights which are mounted both towards the centre of the combined manifolding. To prevent rattle, which is often associated with this type of manifold heater, an open C-spring is fitted between the flap-valve spindle, and a peg in the valve housing. Very thick insulating washers are used between the inlet and exhaust manifold, and also at the carburettor joint.

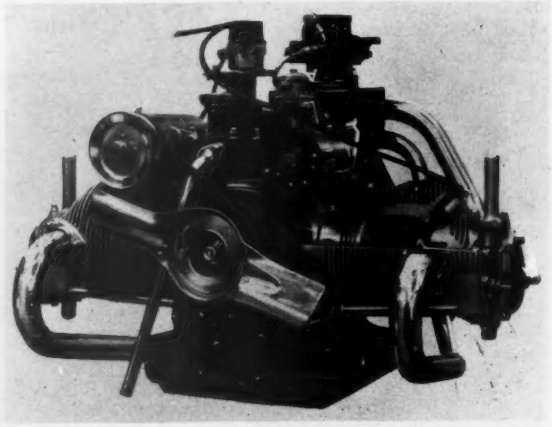
The front suspension is of the familiar Mercedes double-wishbone pattern, and as previously, a certain amount of flexibility is introduced by mounting the wishbone anchorage points on vertical "pivots". A fore-and-aft link coupled to a projection on the lower wishbone bearing is anchored to the frame with thick rubber packings to permit slight flexibility but prevent any substantial movement.

At the rear of the chassis the final drive unit is mounted inboard with swing axles and coil springs to form the suspension. Longitudinal torsion bars are also built into the rear suspension assembly. By means of electrically controlled abutment stops, these can be employed at will to stiffen the suspension when the car is laden. Excessive deflection of the rear wheels could produce peculiarities in the steering. Accordingly, an additional helical spring is mounted inside the main suspension spring and will contact with the outside of the conical rubber bump stop and modify the suspension rate.

Making its first appearance at the Salon was the Simca Aronde. This car, in the popular, family price range, created considerable interest. The four-cylinder, overhead-valve engine is of orthodox construction but the cylinder head is of die-cast aluminium alloy. Having a swept capacity of just under 1¼-litres, it develops 45 b.h.p. at 4,400 r.p.m.



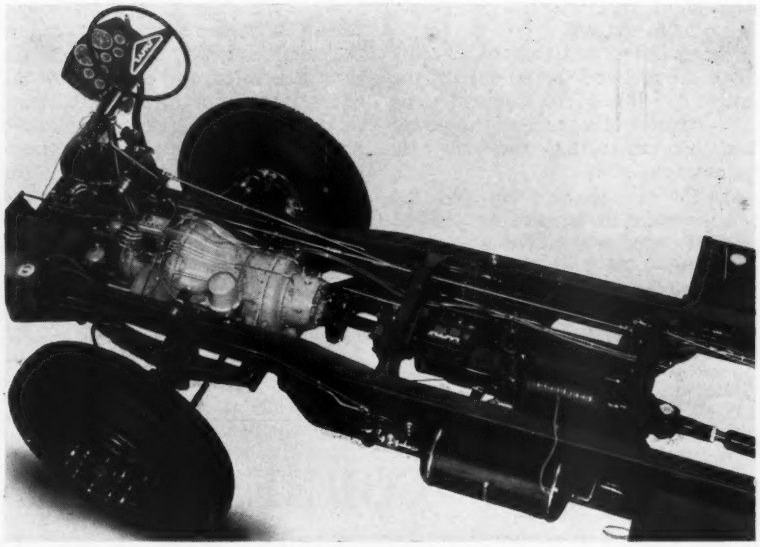
Mercedes type 220 engine



Dyna Panhard engine

Transmission is by a single-plate clutch to the four-speed, synchromesh gearbox and a hypoid final drive. In spite of the fact that a hypoid gear is used, it is necessary to run quite a deep tunnel in the rear of the car. Front suspension is independent by long and short wishbones and coil springs, while the steering is arranged by means of the three-piece track rod and slave-lever system. There is a universal joint in the steering column and the gear change mechanism mounted on this column is interesting in that it employs a single rod in conjunction with a flexible cable.

The top wishbone fulcrum assemblies are bolted to the front cross member is such a way that the camber angle of the road wheels can be adjusted by shims. The rear suspension is by half-elliptic springs and controlled by telescopic shock absorbers.



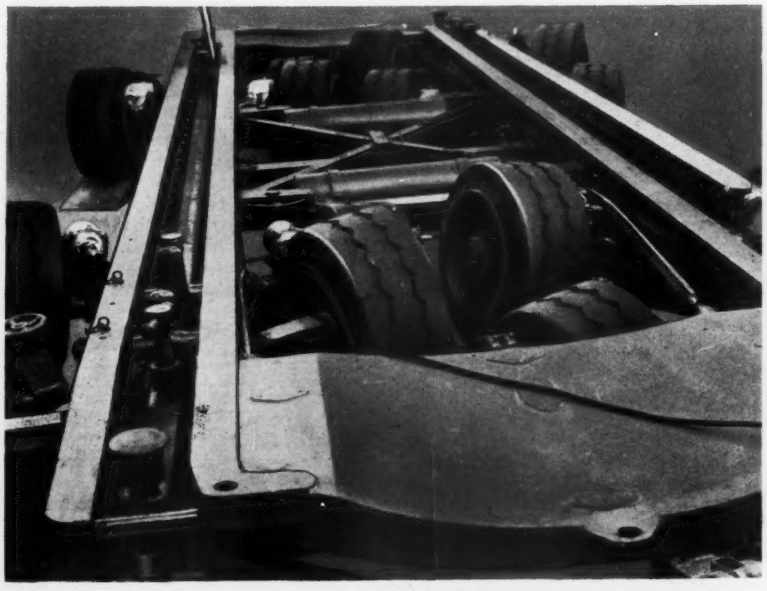
Laffly turbine-powered chassis

The French Ford Company have increased their range by the inclusion of two new models, both on a Vedette chassis which, with a V-8 engine, remains unchanged. To cater for a market that demands a car with a more distinctive line than the standard saloon, the Comet is available with bodywork produced by Facel-Metallon. Styled as a two-door, four-seater saloon, the body has a smooth yet restrained line. The rear window is of three-piece construction, the curved ends extending forward almost to the junction of the rear quarter-light. This model is also available with a Cotal gearbox.

For the other end of the price range a simplified version of the Vedette is produced. On this model the rear quarter-lights have been removed and an extremely large opening is provided by means of two flaps hinged in the horizontal plane at the rear of the car to enable a large quantity of luggage to be carried. To increase the luggage space the rear seats, which are of hammock construction, are arranged to fold up and clip to the roof of the car, leaving a floor space equivalent to that of a station wagon.

Unorthodox in construction in that it employs a V-6 overhead valve engine, the Lancia Aurelia created considerable technical interest when it was first announced. The range has now been extended and the new version, the type B.21, has a bore and stroke of 72 mm and 81·5 mm, giving a capacity of 1,911 c.c. The compression ratio is 7·8 : 1 and the engine develops 70 b.h.p. at 4,500 r.p.m. compared with 56 b.h.p. at 4,000 r.p.m. on the type B.50 chassis, which has the 1,754 c.c. engine.

A speed of some 90 m.p.h. is claimed for the standard five-seater saloon. Another model, known as the type V.20, with the 1,911 c.c. engine running on an 8 : 1 compression ratio, and fitted with two Weber carburettors, produces 75 b.h.p. at 4,500 r.p.m. With an overall gear ratio of 3·71 : 1 a two-seater sports saloon is claimed to run at 100 m.p.h. and yet give an average petrol consumption of 25 m.p.g.



Moncenisio steering trailer

Among the commercial vehicles exhibited, considerable interest was shown in the gas turbine-powered, 10-tonner chassis shown by Laffly. Although this is as yet only a prototype, it is interesting to record that others have followed the lead given by the Rover Company in producing a power unit of this type suitable for road vehicle propulsion. The problems involved are very considerable yet it may well be that owing to space limitations, if for no other reason, the gas turbine will be found in the commercial vehicle world before it is used for private cars.

The power unit on the Laffly chassis consists of an air compressor, two combustion chambers, a compressor turbine and an independent two-stage work turbine. The compressor turbine runs at 30,000 r.p.m., while the work turbine runs up to 24,000 r.p.m. Speed regulation is by means of the accelerator pedal which controls the injection of fuel. The engine is started on petrol and will then run on low-grade distillate fuel. An average fuel

consumption of 450 gr/c.v/hr (1 lb/b.h.p/hr) is claimed.

Apart from problems of filtering both the fuel and the air supply, the major difficulty at the moment is one of successful utilization of the power available rather than the ability to produce the power unit.

In the case of the Laffly unit, the work turbine is coupled to a 10 : 1 reduction gear which gives a propeller speed of 2,400 r.p.m. A two-speed and reverse gearbox is also incorporated but this is only required for starting from rest and manoeuvring, the remainder of the speed control being by means of the accelerator pedal. With a reciprocating engine the compression pressure, when the throttle is lifted, will rapidly slow the engine, that is not the case with a mass rotating at speeds approaching 24,000 r.p.m. Therefore, a seven-disc transmission brake is fitted between the output shaft and the final drive and interconnected with the accelerator pedal in such a way that it will apply a certain amount of braking when the throttle is closed. This is further supplemented by a servo when the brake pedal is applied. This mechanism cannot help the overall efficiency of the unit due to the fact that a large percentage of power must be converted into waste heat every time the turbine mass is decelerated. There would, no doubt, also be the problem of keeping the multi-disc brake system sufficiently cool to prevent fading.

For commercial vehicles, where space is more readily available than is the case with private cars, it may well be that some form of turbo-electric drive would simplify control. However, such equipment is not light in weight and, therefore, its use would perhaps only be warranted on the larger type of vehicle.

CORRESPONDENCE

Correspondence on subjects of technical interest is invited. The name and address of the writer must be given, though not necessarily for publication. No responsibility is accepted by the Editor for the opinions of correspondents, and the right is reserved to omit any portion of a letter. If a reply by post be desired, a stamped addressed envelope should be enclosed.

THE GREASE GUN

SIR,—As a garage proprietor I was very interested in your correspondent's remarks regarding the grease gun and oiling systems in your November issue. May I enlarge a little on this subject. In the first place, is the modern motorist expected to grovel underneath his car for the sake of a few shillings? His running costs for other items such as petrol, tyres and batteries reach proportions that make a greasing charge appear trivial.

The oiling systems he mentions do not absolve the owner from attention to the fan, distributor, water pump, universal joints and the numerous control rod joints, not forgetting certain oil levels to check and various filters to clean. Furthermore, accidental damage to any of the pipe lines, about which the owner may have no indication until the parts served by the damaged section seize or fail, constitutes a weakness of all such oiling systems. The use of rubber pipes is hardly a solution, as they are liable to be chafed or rotted through in no great period of time.

The oiling system mentioned as fitted to the trolley buses, is vastly different. Each pipe line has its own pumping unit and feeds oil proportionately to the mileage, as it is driven from the propeller shaft and not by the engine or at the whim of the driver. A pipe fracture here, at least, does not starve the remaining points of the chassis.

As for your correspondent's other points, a foolproof system does not exist, cost having no bearing on the matter. The garage trade, myself included, would not be sorry to lose the dirty job of greasing, at present attended to in the hope of more worthwhile jobs eventuating. Considering the amazing things that can happen to a car, there is no likelihood of the owner failing to visit the repair shop.

As for my opinion on greasing, I suggest it be changed to oiling and the use of gear oil. Why not follow the American dashpot oiling system? Fill the pot with gear oil at intervals and it seeps into the bearing as needed. It is simple to install, easy to service and works effectively.

C. E. MILLS,
Miles Motors (Holborn)
London, W.C.1.

SIR,—Your leading article "The Grease Gun" which appeared in the October issue, draws attention to the difficulties which beset the car owner when attempting to lubricate the chassis of his car with the grease gun, which the car manufacturer provides in the tool kit. After describing these difficulties and their attendant hazards, your article offers the demoralized motorist the alternative of entrusting this vital job of lubrication to a Service Station, adding that the organizations which can be relied upon to do the job properly, however, are relatively rare. We do not feel disposed to let that statement pass unchallenged.

May we, then, bring to your notice the existence, over a long period of years, of a not inconsiderable number of garages operating Tecalemit Service. Their *raison d'être* may be said to be the efficient lubrication of car chassis so that owners may be freed from any responsibility in this direction other than the purely financial.

Furthermore these garages which operate Tecalemit Service have in all probability, at some time or another, taken advantage of the Training School facilities offered by this Company. This School has always had as its educative aim the training of operators, not only in the proper use of up-to-date, high-pressure lubricating and servicing equipment manufactured by this Company, but in the art of customer approach and follow-up. It is, in fact, the desire of all Tecalemit Stations to bring the wayward motorist back every 500 miles for regular service, so that his car—chassis, springs, gearbox, back axle and engine—may be maintained in a proper state of lubrication.

D. M. BRUCE,
(Editor, *Tecalemit News*)
Brentford, Middlesex.

(We are in complete agreement with our correspondent as to the desirability of passing the work of lubrication on to the expert. As in most matters today, however, current standards are often not all that might be wished. There are also the cases where motorists live in isolated districts and where running costs are a dominating factor.—*Editor.*)

UNDERFLOOR ENGINES

SIR,—In the Motor Show Issue of *Automobile Engineer* your reviewer of current engine design wonders which will be the first firm to fit a flat engine under the front seat.

While Mr. Leslie Hounsfield would probably make no claim to be the earliest designer to choose this position, he has, at least, the satisfaction of knowing that his layout for the Trojan car, which placed the engine as your reviewer suggests, was employed for nearly twenty years. The lessons learned during those years have not been neglected and if, as it now seems possible, prejudice against this position for the engine has diminished, it can be agreed that the underfloor engine is not without its attractions for private cars as well as for commercial vehicles.

JOHN B. PERRETT
Technical Manager,
Trojan Limited
Croydon.

GEARBOX MANUFACTURE

Production Developments at the Works of Vauxhall Motors Limited

AS part of the comprehensive reorganization that is being carried out by Vauxhall Motors Ltd., Luton, the whole of the gearbox manufacturing functions have been transferred to an area in the new factory building. In this area all the detail machining and assembly are carried out for the gearboxes of all classes of vehicles. These notes deal only with the methods employed in the production of gearboxes for passenger vehicles. Many interesting innovations have been made, particularly in the detail machining sections, which have been almost completely re-tooled and include many machine tools that have been specially designed for specific multiple operations on specific components.

Each of the detail machining sections is laid out to give flow production with the final operation occurring at the nearest possible point to the section to which the part must be delivered either for further processing or for assembly. Particular care has been taken to reduce material handling to the minimum. Unit pallet loads of components are delivered by fork truck to the starting point of the appropriate section. Handling of components during the actual machining cycle has been minimized by the use of multi-station machines wherever possible and where a single-station machine is used, by the use of multi-tooling where it is practicable.

When the component is of a suitable character, movement of the work from one machine to the next is effected down a chute that brings the work into a position convenient for the machine operator. Where the work has to travel some considerable distance between sections, and there are, of course, instances where this is unavoidable, transfer from one section to another is in great measure effected by means of overhead conveyors. In other cases, transfer between sections is effected on wooden "A"-shaped frames mounted on four-wheel bogies. In general, individual handling of components has been reduced to the lowest economically-practicable amount.

Gearbox casing machine line

Of the detail machining lines, without doubt the most interesting is that for machining gearbox casings for passenger vehicles. Two sizes of gearboxes are produced on this line, one for four-cylinder and one for six-cylinder engines. A certain amount of tool changing is necessary when a change is made from one size to the other. In addition, the line is equipped for machining either right- or left-hand drive gearboxes.

A single aluminium casting forms both the gearbox casing and the bell housing. In view of the amount of machining that is necessary, the casting is machined complete ready for assembly with remarkably little handling. In fact, through the use of one transfer machine and several multi-station or multi-tool machines, each casting is loaded into and unloaded from a machine only five times in the complete cycle.

The first machining operations are carried out on a special Footburt two-spindle, three-station vertical machine illustrated in Fig. 1. A power-operated circular indexing table carries a pot-type work-holding fixture at each station. The casting is loaded into the fixture with the bell housing flange uppermost. Height location is taken from three fixed pegs on which the underside of the flange rests, while radial location is taken from a fixed peg which registers against a cast lug on the flange. The workpiece is centralized in the fixture by three equalizing jaws which contact the side of the bell housing flange, and by an expanding tapped bung with three jaws that register in the cored hole in the rear face of the gearbox casing.

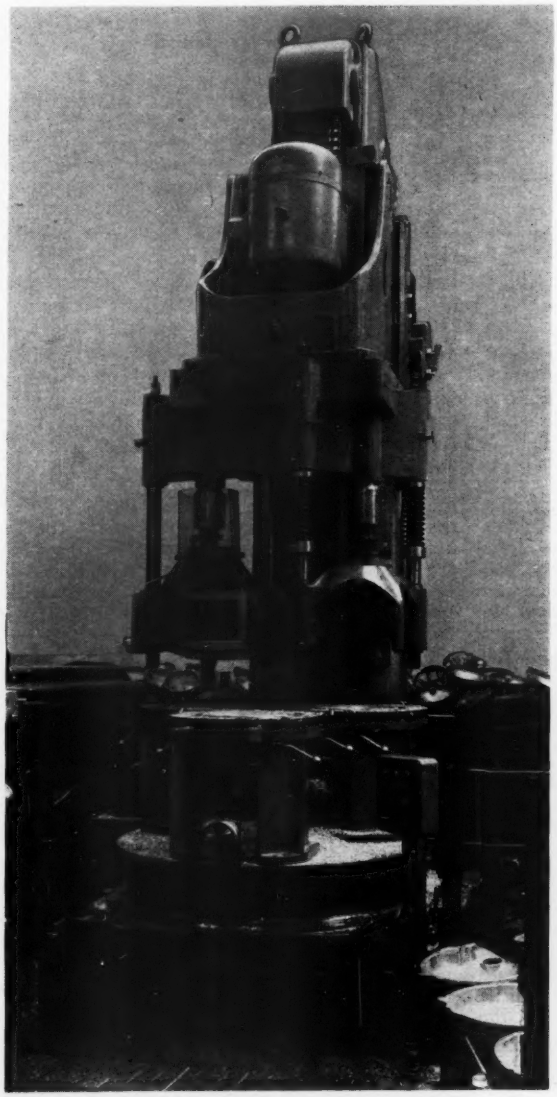


Fig. 1. Three-station, two-spindle Footburt machine for the first operations on the gearbox casing

Clamping is effected by means of a profiled ring that contacts the casting at several points round the periphery just below the bell housing flange. Movement of a simple lever applies the ring and gives secure clamping. As this casting is of a form that could easily be distorted if too great a clamping pressure were used, a definite restriction is placed on the lever movement to eliminate any danger of excessive clamping pressure and consequent distortion.

Two carbide-tipped tools are mounted in the spindle head at the first working station. One faces the bell housing flange while the other machines a counterbore in the front face of the gearbox casing. At the second working station a carbide-tipped facing tool faces the front face of the gearbox casing. A fully-automatic work cycle is employed. Depression of a push-button causes the table to index, both heads then

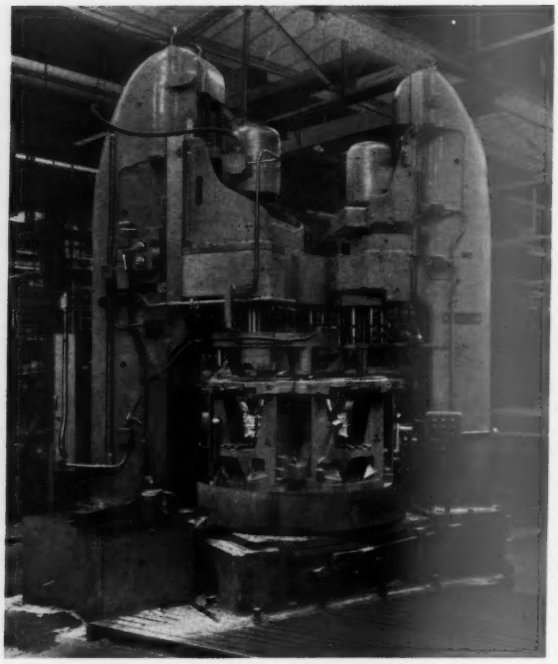


Fig. 2. Footburt five-station, 57-spindle drilling, reaming and tapping machine for gearbox casings

advance rapidly to the work, the spindles start and the cut is taken at feed rate, and at the end of the cut the spindles retract and stop. The various machine movements are interlocked in such a manner that indexing cannot be effected inadvertently while the spindles are in any position other than fully retracted.

From the first machine the work is passed to another specially-designed Footburt machine, shown in Fig. 2. This is a five-station, 57-spindle drilling, reaming and tapping machine, with a power-operated circular indexing table. Pot-type work-holding fixtures are used, and once again the casting is loaded into the fixture with the bell housing flange uppermost. The casting is pushed into position through an opening in the side of the fixture and is then raised by simple movement of a lever. This brings the machined face of the bell housing flange into contact with three pads on the fixture to give height location, while radial location is by means of a fixed plug that contacts a lug on the bell housing flange. The work is centralized by three equalizing pads that contact the side of the bell housing flange, and clamping is effected by similar means to those employed at the first operation.

Loading and unloading are carried out at the first station. At the second station the mainshaft bore is rough and semi-finish bored, counterbored and chamfered from one spindle, while from the other two spindles, the layshaft hole is drilled in the front face of the gearbox casing and the reverse shaft hole is drilled through two walls. One combined reaming and counterboring operation and several drilling operations are carried out at the third station. The counterbore in the front face of the gearbox casing is finished to size and from the same spindle the mainshaft bore in the front face is reamed to leave an allowance for fine boring at a subsequent operation. Also at the third station, six holes are drilled in the front face of the gearbox casing and 14 in the bell housing flange. Work is also carried out on both the front cover face and the bell housing flange at the fourth station. Five holes are chamfered ready for tapping, and the layshaft and reverse shaft holes are reamed to leave an allowance for subsequent fine boring. All the tapping holes in the bell housing flange are either chamfered or counterbored at the fourth station, while four holes in this flange are reamed, two to give locations for subsequent operations and two that at a later stage are fine bored for engine mounting.

The spindles at the second, third and fourth stations are mounted in a common head carried on a column. As the head advances, an apron advances with it to bring the drill guide bushes into close proximity to the work. Special drill guide bush carriers are used for the tools that operate on the front cover face. They are of a form that allows them to advance into the casting so that the tools are guided close to the work.

All the necessary tapping on the front cover face and the bell housing flange is effected at the fifth station on this machine. The tapping head is mounted on a separate column and has its own individual drive, so that in effect there are two machines served by a common circular indexing table. As with the machine used at the first operation, this machine has a fully automatic cycle and has the various movements interlocked to prevent any possibility of incorrect operation. From the second Footburt machine the casting is passed to a special Barnes two-spindle milling machine see Fig. 3, on which the gearbox casing top cover and rear end faces are milled at one pass. It has a vertical head for the rear end face and a horizontal head for the top cover face.

Transfer machining

Except for two operations at the end of the machining sequence, all the remaining machining on this casting is carried out on a special 21-station, 125-spindle Footburt hydraulic milling, drilling, reaming and tapping machine. For good reasons, the casting is mounted on a jig plate for passage through the transfer machine. In the first place, this simplifies the change-over from one type of gearbox to the other. For example, the necessary height adjustment for the change from a long to a short casting is made by mounting a secondary jig plate on top of the jig plate used for the longer casting. Another reason for using a jig plate is that the casting is of a form that is not really suitable for individual clamping and unclamping at every station in its passage through the machine.

Location of the work on the jig plate is taken from the bell housing flange face and from two reamed holes in the flange. Four clamps are used to fasten the work securely to the plate. The jig plate itself is square and has accurately machined pads on all four sides. It has two reamed holes in the underside into which dowels register at each transfer station to give accurate location. This jig plate also allows very simple clamping arrangements to be employed. At each station there are two clamps, one on either side of the transfer bar, which are automatically pulled down to hold the plate securely in the correct position. At the end of

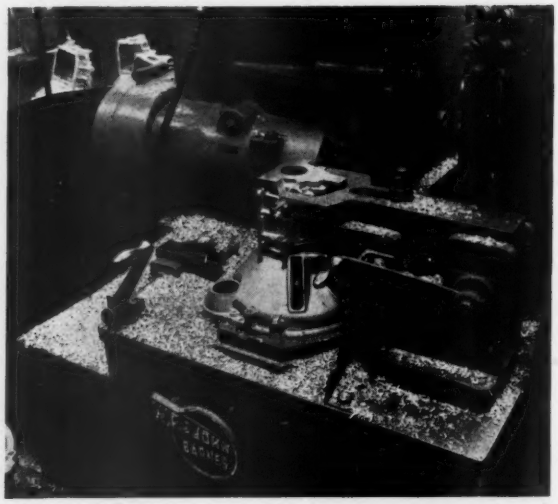


Fig. 3. Special Barnes two-spindle miller for milling the rear end and the top cover face of gearbox casings at one pass

each cycle they are automatically lifted clear and the dowels are retracted to allow the plate, and with it the work, to be transferred to the next station.

Loading of the work on to the jig plate is carried out on a length of roller conveyor at right angles to the loading station of the machine. The roller conveyor and the machine loading station are shown in Fig. 4. Once the jig plate, with the work clamped to it, has been placed on the first station of the machine, its passage through the complete cycle is fully automatic. At the end of each operation cycle, the operator merely presses a push button to cause every plate to be advanced one station, to be located and clamped automatically. The work heads then advance and retract, the clamps are released and the dowels withdrawn, ready for another cycle to be initiated. At the loading end of the machine there is a control panel, see Fig. 5, which gives warning to the operator if any of the machine functions fail.

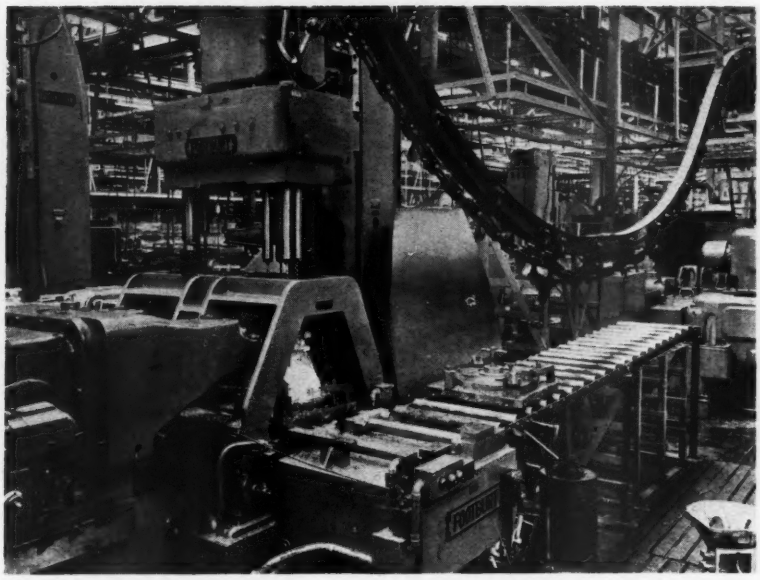


Fig. 4. Loading conveyor for the 21-station Footburt transfer machine. Part of the overhead conveyor for the return of jig plates is also shown

Two machines, one at either side of the transfer rails, serve the second and third stations. At the left there is a special two-spindle milling machine, and at the right an eight-spindle vertical drilling machine. A face milling cutter is mounted above the head at the second station. It is used for milling the reverse gear facing on the inside of the rear end of the box, while five holes are drilled from the vertical drilling machine. At the third station a similar face milling cutter is mounted below the head for machining the front end reverse gear facing. While this milling operation is being carried out, the mainshaft bore in the rear end of the casting is rough and semi-finish machined, counterbored and chamfered from the vertical drilling head. At the same time the layshaft hole is drilled in the rear end and the reverse shaft holes are drilled through two walls.

Between the third and fourth stations, provision is made for blowing out the casting. This is necessary because of the amount of swarf that is produced in the milling operations. The machines for the fourth and fifth stations are so arranged that at the fourth station machining is effected only from the left, while at the fifth, machining is effected from both sides. At the left of the transfer rails there is a two-spindle special milling machine similar to that used at the second and third stations. This machine is illustrated in Fig. 6. In this case a facing cutter mounted above the head, mills the layshaft rear gear facing at the fourth station. At the fifth station a second milling cutter mounted below the head of the machine at the left, mills the layshaft front end facing and the front outside face of the reverse shaft bearing. Also at the fifth station, but at the right-hand side of the line, there is another two-spindle milling machine. This carries right- and left-hand face mills for machining the side faces of the shifter gear bosses. This machine is illustrated in Fig. 7.

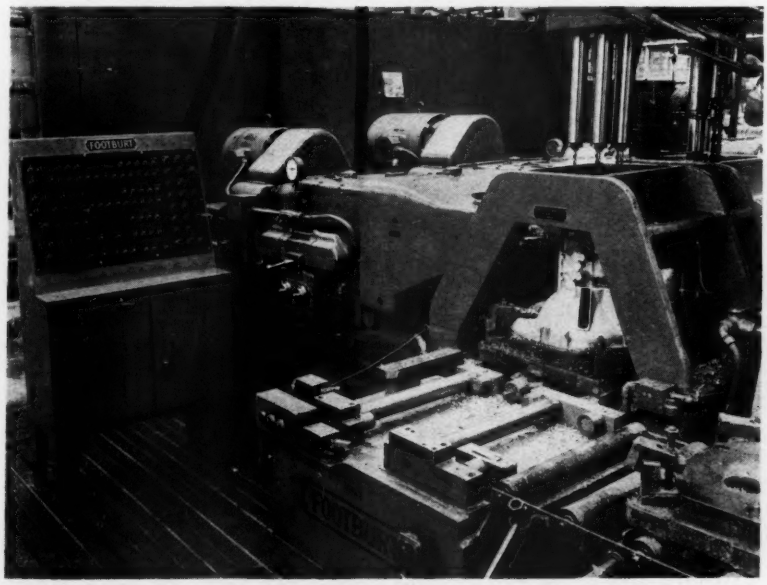


Fig. 5. Control panel and loading station of the transfer machine

The sixth is an idle station. A considerable amount of swarf is produced at the four previous stations, particularly by the milling operations, and this idle station serves as a clearing station for the swarf. Most of the swarf as it is produced falls into a trough beneath the transfer mechanism. Thence it is brought to the idle station by a continuously rotating Archimedean screw. This station also serves for clearing swarf from some of the subsequent stations, since there is another Archimedean screw of opposite hand rotating in the trough below several of the succeeding stations.

A 21-spindle horizontal drilling machine on the left and a 10-spindle vertical drilling machine on the right serve the seventh and eighth stations. At the seventh station, 10 tapping holes in the top cover face and a tapping hole for the drain plug are drilled from the horizontal head, while the reverse shaft hole in the rear end is opened out and counterbored, and five holes in the rear end face are chamfered ready for tapping from the vertical head. At the eighth station the 10 holes drilled in the top cover face at the seventh station are counterbored from the horizontal head, while from

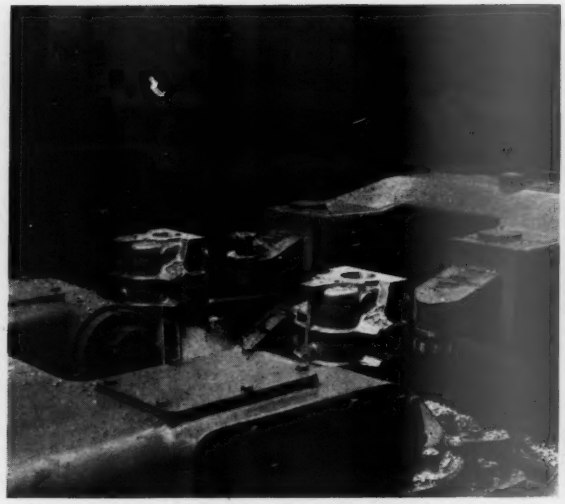


Fig. 6. Two-spindle special milling machine operating at the fourth and fifth stations of the transfer machine

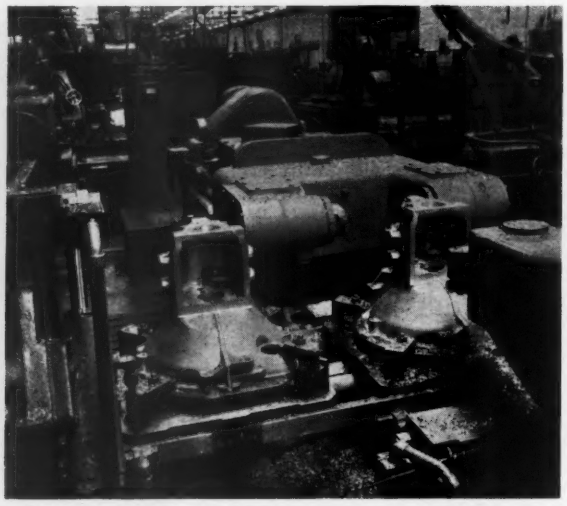


Fig. 7. Two-spindle special milling machine for milling the side faces of the shifter gear bosses at the fifth station

the vertical head the reverse shaft and layshaft holes are semi-finished ready for fine boring and two holes are drilled in the end face.

The ninth station has a five-spindle vertical tapping machine at the left. It is tooled for tapping holes in the rear end face. At the right-hand side there is a four-spindle angular drill. Only two of these spindles are used simultaneously. Which they are is dependent upon whether the casting is for use with four- or six-cylinder engines. The machines at the tenth station comprise an 11 spindle horizontal tapping machine at the left and a four-spindle angular tapper at the right. The horizontal machine is used for tapping the holes drilled at the seventh station for the top cover face and the drain plug, while the angular head taps the holes drilled at the ninth station.

At the eleventh station, see Fig. 8, the jig plate, and with it the casting, is automatically indexed through 90 deg. The transfer bar is in two lengths and the division is made at this station. One bar pushes the plate forward from the tenth to the eleventh station, then while the work cycle takes place at the other stations, the plate is indexed ready for transfer forward by the second transfer bar.

Two multi-spindle horizontal drilling machines, one on either side, serve the twelfth and thirteenth stations. They are used for straightforward drilling operations. Incidentally, for a left-hand drive box only one of the spindles on one side is used, while for a right-hand drive box, only one of the spindles on the other side is used. Two horizontal multi-spindle drill heads serve the fourteenth and fifteenth stations. In addition there are two two-spindle drill heads at either side of the transfer rails at station fifteen. Up to this stage, all the horizontal tools have worked in a plane normal to the longitudinal axis of the machine, but the two-spindle drilling heads are set at an angle of 16 deg to this axis. At these two stations only the machines on one side of the line are in use at any one time. That is, the machines on one side are used for right-hand drive boxes and those on the other side for left-hand drive boxes. In addition, only one spindle of the two-spindle head is in use at any one time.

It is necessary to use a long drill for the hole that is drilled from the angularly disposed head and it is impossible to use a fixed drill guide bush that is close to the work since such a plate would interfere with the transfer of the work to the next station. For this reason, the guide bush plate is inter-connected with the movement of the head so that it is automatically advanced to a position that gives adequate support to the drill as the head advances and is automatically withdrawn as the head retracts. This head is shown in Fig. 9.

Fig. 8. The indexing station on the transfer machine. The casting is turned through 90 deg. on the vertical axis

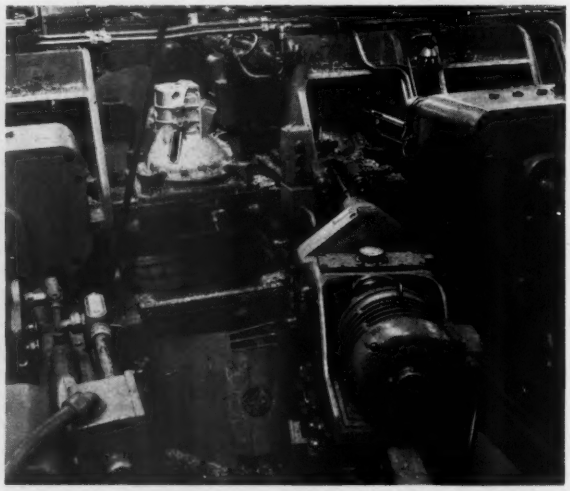


Fig. 9. One of the horizontal drill heads. The drill guide bush plate advances and retracts with the head

The sixteenth station is another idle station which is used as a swarf clearing station in the manner described for the sixth station. For the seventeenth and eighteenth stations there are once again two horizontal multi-spindle drilling machines, one on either side of the line. At these stations seven holes are reamed to size. Only one machine is used at a time, dependent upon the hand of the casting that is passing through. The nineteenth and final working station has a three-spindle and a two-spindle horizontal tapper at the left of the line, and a four-spindle and a two-spindle horizontal tapper at the right. Only one of the angular heads is used for any one type of box. The twentieth is an idle station, and at the twenty-first, the casting is removed from the jig plate ready for transfer to the next machine. Fig. 10 shows these three stations.

The machining cycle on this transfer machine is under 90 seconds. As with other transfer machines, the various machine movements are interlocked so that the clamps cannot be applied until the locating dowels have registered in the location holes in the jig plates, and the heads cannot advance until the clamps are applied. Transfer is effected by an interesting method that differs from the spring-loaded pawl-type pushers that are generally employed. On this machine the very substantial transfer bar has fixed pushers which are vertical for the advance stroke. For the return stroke, the bar turns through an angle of 45 deg to bring the pushers completely below the bottom of the jig plate. This arrangement for transfer seems to have advantages, particularly where a good amount of swarf is produced, since it completely eliminates any danger that swarf might prevent correct operation, which is a possibility, albeit remote, with spring-loaded pawl-type pushers.

After the casting has been removed from the jig plate, it is pushed on to a short length of roller track at right angles to the transfer rails, see Fig. 10. Here it is cleaned of all swarf. A hydraulic ram then lifts the conveyor and the plate to bring the conveyor into line with another length of overhead roller conveyor. At the end of its upward travel, the roller conveyor is given a slight tilt so that the plate runs off on to the overhead roller conveyor. This length has a gentle fall so that the jig plate runs down it under gravity until contact is made with a stop that brings the plate into position under a travelling overhead conveyor. This conveyor has carriers so designed that the jig plate is automatically picked up for conveyance to the loading end of the transfer machine. As it approaches the loading position, the overhead conveyor falls to a height that allows the jig plate to rest on the loading length of roller conveyor. The overhead conveyor and the loading conveyor are shown in Fig. 4. As soon as this occurs the carrier automatically releases the plate, which then moves by gravity down the roller conveyor to the position at which another casting is clamped ready for machining.

Fig. 10. The final working station and the unloading station on the Footburt transfer machine

Machining of the gearbox casing is completed by two further operations. At the first of these a light skimming cut is taken across the flange face. Finally, the mainshaft, layshaft, reverse shaft and engine mounting bores are fine bored to size on a double and Ex-cello precision boring machine. The work is then washed, blown-out and inspected before being loaded on to an overhead conveyor for transfer to the assembly conveyor.

Rear end cover

An aluminium casting is used for the gearbox rear end cover. It is not of a form that lends itself to transfer machining, but handling during the machine cyele has been minimized by the use of multi-station, multi-tool machines, as far as is economically possible. The first machining operation is carried out on the Snyder four-station, double-end, trunnion machine, illustrated in Fig. 11. There are three working stations. The casting is held in vees and is located endwise from the support foot boss. At the second station the small end is bored from the right-hand head to a diameter that leaves an allowance for fine boring at a later operation, while the recess is counterbored in the large end from the left-hand head. The small end is faced from the right hand head at the third station, while from the left-hand head three holes are drilled and two holes are drilled and reamed by combination tools in the flange face. To complete the sequence on this machine, a centring tool in the left-hand head produces a $\frac{1}{16}$ in $\times$ 60 deg chamfer on the bore at the rear end, while the bore at the flange end is opened out to a size that leaves a machining allowance for fine boring at a subsequent operation.

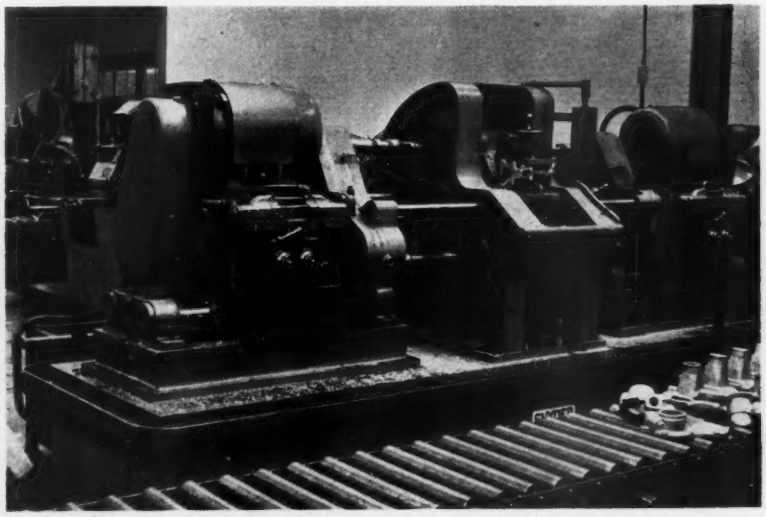


Fig. 11. A Snyder four-station, double end trunnion machine for the first operations on gearbox rear end covers

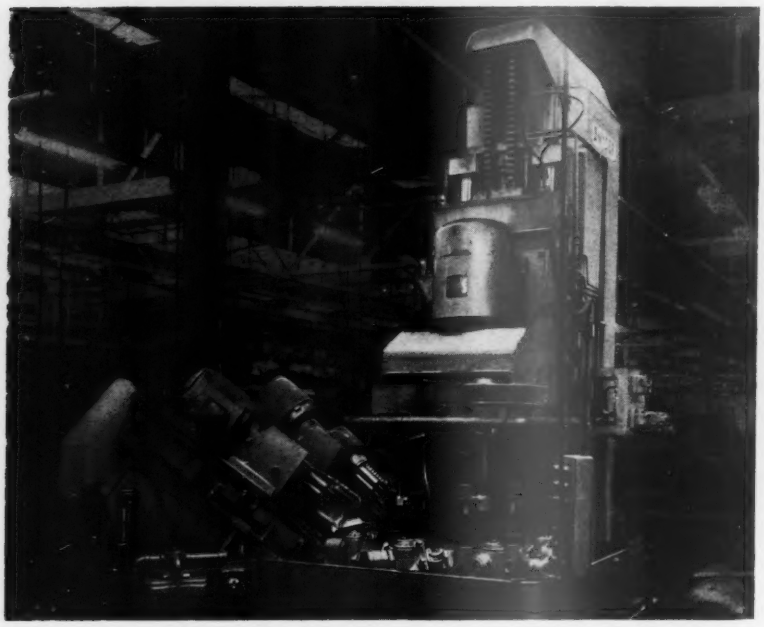


Fig. 12. Special Snyder eight-station drilling and reaming machine for rear end covers

The second machining operation is carried out on a No. 1 Maxicut lathe. Location is taken from the machined bore at the flange end and from the chamfer in the rear end. On this machine all the external turning, chamfering and grooving operations are carried out and the flange is faced at one setting. The casting is then passed to a Cincinnati plain Hydromatic milling machine on which the speed housing face and the support foot face are milled. Two castings are milled at one pass, one standing vertically and the other horizontally, so that for every pass the milling is completed on one casting. On each of these fixtures, location is taken from the flange face and two reamed holes in that face.

A special Snyder eight-station multi-spindle drilling and reaming machine is used for the next operations in the sequence. This machine is shown in Figs. 12 and 13. Eight work-holding fixtures are mounted on a power-operated circular indexing table. Location is taken from the flange face and from the machined bore in the flange end, and radially from one of the holes drilled and reamed at the first operation. Clamping is effected by means of a plug that fits the chamfer of the rear end bore.

At the first working station a single spindle vertical head is used for drilling a hole in the speed housing face. A three-spindle angular head at the second working station drills three holes, which are spot-faced from another angular head at the third working station. At the next station the hole in the speed housing face is reamed to size, and at the fifth working station, another hole on the same axis is reamed. A four-spindle vertical head at the sixth working station is used for drilling four holes in the support pad, and at the seventh these holes are chamfered.

All the tapping is carried out at one setting on the Snyder two-way multi-spindle tapping machine shown in Fig. 14. The work-holding fixture and the method of location are the same as at the previous operation. Four holes in the support pad face are tapped from the vertical head and two holes are tapped from the angular head. The rear end of the cover is then fine bored to take an anti-friction bearing bush, and after the bearing has been inserted, a double-end Precimax fine borer is used to finish bore both ends. To complete the machining, the flange face is given a shim cut to ensure that it is perfectly square with the bores.

Other special machines

It is not intended to describe in detail the manufacture of shafts, sliding sleeves and gears, but there are some other multi-station, multi-spindle machines that are worthy of mention. For example, the special Snyder seven-station, double-end, trunnion machine illustrated in Fig. 15, is used for the first machining operations on the blank for the second and third speed sliding sleeve. The blank as supplied to the machining section is $3\frac{1}{2}$ in long and has a rough drilled $1\frac{3}{8}$ in diameter hole down the centre.

At the first working station rough boring cutters in each head open out the ends to $2\frac{1}{16}$ in diameter. These bars run at 418 r.p.m. to give a cutting speed of 220 ft per minute. A feed of 0·0017 in per tooth is employed. At the second working station, two diameters are rough bored from the left hand head and one is finish bored from the right-hand head at the second working station. Once again a cutting speed of 220 ft per minute is employed with a feed of 0·0018 in per tooth. At the third working station one diameter at each end is finish bored, again at a cutting speed of 220 ft per minute.

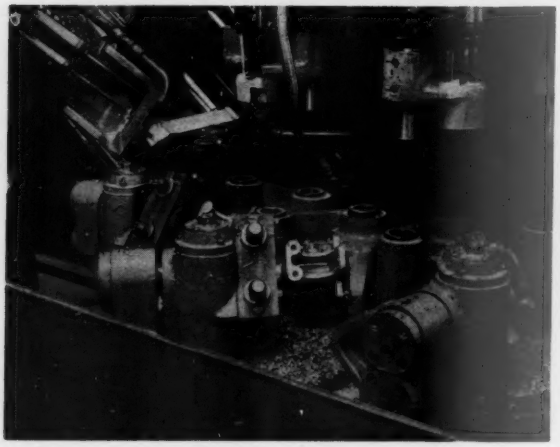


Fig. 13. The work-holding and locating fixtures on the machine illustrated in Fig. 12

Fig. 14. Snyder special two-way tapping machine for rear end covers

One diameter is finish bored from the left-hand head at the fourth working station, while a diameter is rough bored and two chamfers machined from the right-hand head. At the fifth working station the main bore is finished to size and two chamfers are machined from the left-hand head. The operations on this machine are completed at the sixth working station where an eccentrically-mounted, spring-loaded grooving tool in each head is used for machining a Circlip groove. At all operations other than the final one, the cutting speed is 220 ft per minute. For the grooving operation the cutting speed is 150 ft per minute and the feed is 0·0028 in per revolution. The total time cycle is 60 seconds.

Another special purpose machine is illustrated in Figs. 16 and 17. It is a milling, drilling, centring and turning machine specially designed by Adcock and Shipley Ltd., Leicester, for the first operations on the mainshaft. Essentially, this machine comprises a base on which two columns are mounted; carried between the columns is a hexagon turret with six sets of fixtures for holding the components. Also mounted on the base are sub-beds for Adcock and Shipley unit heads suitably positioned for carrying out the various operations.

Each unit head is driven by an individual motor which drives the feed mechanism as well as the spindle. The feed is provided by a hardened barrel type cam whose track can be arranged to give whatever feed cycle is required. All the heads use a cycle of rapid approach, change to cutting feed and then rapid return to the rear position where they stop. Change in the rate of cam rotation, with consequent change in the cycle time and feed rate, is effected by means of pick-off gears in the head.

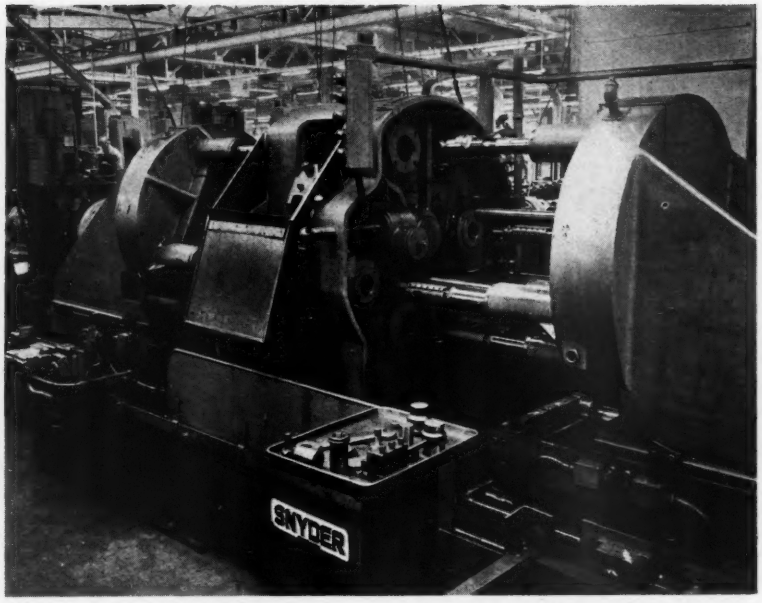


Fig. 15. Seven-station Snyder double-end trunnion machine for the first operations on the 2nd and 3rd speed sliding sleeve

All the unit heads are adjustable on the sub-beds. This allows compensation to be made for tool wear, and should it be necessary, it allows the machine to be used for components of different lengths. In addition to the longitudinal adjustment, the milling heads also have transverse adjustment to and from each other, while the columns are also adjustable along the bed. Six self-centring vice type fixtures are mounted in the hexagon turret. The station sequence is :—

Station 1. Load.
Station 2. Idle.
Station 3. Mill both ends.
Station 4. Drill one end from the left-hand head; centre the other end from the right-hand head.
Station 5. Centre one end from the left-hand head; turn a diameter from the right-hand head.

Loading and unloading are carried out at the front of the machine, see

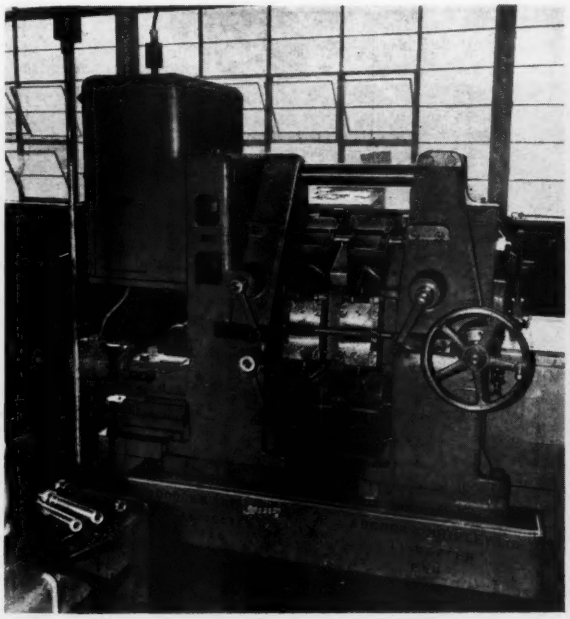


Fig. 16. Adcock and Shipley combined milling, centring and turning machine for mainshafts

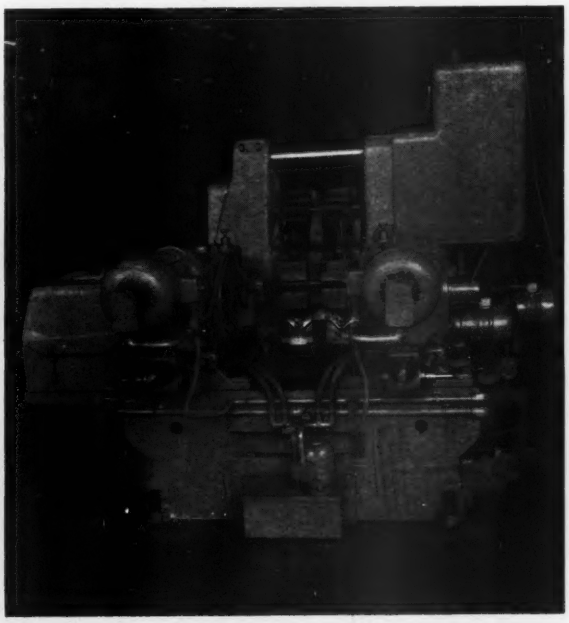


Fig. 17. The milling heads on the Adcock and Shipley machine shown in Fig. 16

Fig. 16. Turret indexing is by means of a handwheel operating through worm and wheel reduction. Each side of the turret is fitted with a locating plunger. The left-hand end of the turret is pulled up against the column face after indexing to give a lock and ensure rigidity. To provide additional support, the right-hand end of the turret is locked by a split clamp.

A pair of Adcock and Shipley size 2S unit heads, see Fig. 17, are used for milling across the ends of the mainshaft at the third station. They are driven by 3 h.p. motors and have special milling units fitted to the spindle ends. A suitable face cutter arbor for carrying high speed face cutters is fitted into each spindle nose. Adcock and Shipley size "O" unit heads carrying centre drills in standard Adcock and Shipley collets are used for the centring operations.

A size 1Q unit head, fitted with a 2 h.p. motor is used for the turning operation. A specially designed circular body box turner is mounted on the spindle. It is steadied in a support bush in the column and carries two single-point tools. The turning operation is carried out to provide an effective grip for a special work driver used at a subsequent operation on an automatic multi-tool lathe. An automatic unit drilling head, size "O", is used for drilling a $\frac{3}{8}$ in diameter by 2 in deep hole.

Heat treatment

Furnace, salt bath and high-frequency induction heating equipment are employed for those gearbox components that need heat treatment. As much use as possible is made of high-frequency induction heating. As is well known, such equipment is capable of very high rates of output, and in addition, the machines can be placed in the most convenient positions in the actual detail machining lines so that transport of components is greatly minimized. There are, of course, many components

Fig. 18. The loading station for pot carburising and the storage hoppers for compound

Fig. 19. The charging end of the carburising furnaces, with the return track for empty pots.

Fig. 20. The slat and jig assembly conveyor for gearboxes. The overhead feeding conveyors are also shown

for which high-frequency treatment is not suitable. Such components are transferred to the heat-treatment section either by overhead conveyor or on special "A" frames.

The heat-treatment section is fully mechanized. It includes carburising, re-heating and tempering furnaces, with all the necessary ancillary equipment such as plant for producing protective atmosphere gas, shot-blasting plant and quenching presses to eliminate gear distortion. In the main section, that devoted to carburising, the carburising compound is delivered mechanically to three storage hoppers above the pot-filling station, see Fig. 18. Supplies of compound are drawn as needed for filling the pots. Packed pots are transferred from the filling station to a charging machine that serves three carburising furnaces. The charging machine is shown in Fig. 18. All three carburising furnaces are of the continuous type with the pots conveyed mechanically through from the charging end to the discharging end. On leaving the furnace the pots pass through a cooling chamber and finish beside another charging machine ready for unloading.

From the charging machine at the discharge end of the carburising furnace, the pots are transferred to a gravity roller conveyor on which they travel to a wire mesh cooling conveyor for final cooling of the carburised parts. The carburising furnaces and the wire mesh cooling conveyor are shown in Fig. 19. The contents of each pot, that is the components and the compound, are tipped on to the wire mesh conveyor. Tipped compound falls through the mesh into an elevator and travels in overhead screw conveyors to the storage and filling hoppers. Meanwhile, the components are carried on the conveyor to the re-heat furnace. The empty pots are returned to the filling station on the charging machine that is used for taking full pots to the carburising furnaces.

Re-heating and tempering furnaces are arranged in pairs. The work passes through these furnaces, which are of the pusher type, on trays. For each pair of furnaces there is a roller conveyor along which the empty trays are returned from the discharge end of the tempering furnace to the charging end of the re-heat furnace.

Special precautions are taken in transporting components from the detail gear cutting section to the heat-treatment section. To ensure that the teeth are not damaged in transit, transport is effected on "A" frames with an individual location for each gear. Finished gears and shafts are transferred to an inspection station for full examination. At this station they are eventually loaded on to an overhead conveyor that feeds the gearbox assembly lines. It is 544 ft long, runs at 8 ft per minute.

Meanwhile, gearbox and covers are being transferred from the detail machining section on another overhead conveyor which feeds the assembly lines. This conveyor is 412 ft long and runs at 6 ft per minute. It has carriers spaced at 24 in and it serves both the passenger and the commercial vehicle gearbox assembly lines. Assembly is carried out on a slat and jig conveyor, see Fig. 20. Sub-assemblies are built on benches conveniently placed beside the conveyor which is 70 ft long and runs at 16 in per minute. All the necessary hand tools, nut runners and the like, are suspended above the conveyor at the appropriate positions. When assembly is completed, every gearbox is given a running test to ensure that it runs quietly in all gears.

In conclusion, it is perhaps worth while to summarize some outstanding features in the methods employed by Vauxhall Motors Ltd. for the production of gearboxes. Firstly, attention may be drawn to the high degree of dimensional accuracy and the excellent quality of surface finish that are maintained wherever necessary even with very high production rates. Secondly, there is the manner in which transfer machining, multi-station and multi-tool machines are used to reduce handling during the actual machining cycle. Thirdly, there are the comprehensive arrangements for reducing the manual transport of components, and finally, the layout of the whole section has been arranged to make the maximum productive use of the available floor area.

The Ferguson Tractor

IN our November issue appeared a full description of a new diesel power unit for the Ferguson tractor. This engine was designed and developed by the Standard Motor Co. Ltd. and is now being produced at Coventry.

The design was commenced early in 1947 and the first prototype engines were of 3 in bore, but subsequently the bore was increased to the present diameter of $3\frac{3}{16}$ in. Numerous units having the larger bore have been subjected to thousands of hours testing, both as an engine alone and as a complete power unit, in which case the test dynamometer was coupled to the power take-off. It was during this testing period that the cylinder top end cuff was invented and developed.

PRIVATE CAR BODYWORK*

Outstanding Designs at the London Show

MOST British manufacturers of saloon cars have made only minor modifications to last year's models. Among these is the Standard Vanguard which has a different radiator grille, a more sloping bonnet crown line, and a horizontal motif on the front of the alligator-type lid. A larger rear window has been incorporated, and push button handles are now fitted to the doors. Inside the car there is a moulded rubber front-floor covering, and the roof lining is in a washable plastic material. On the Hillman Minx saloon, and also on the Carbodies convertible version, a centre motif has been fitted to the grille which is strengthened in appearance by a vertical chromium-plated bar at each side. The appearance of the front wings has been improved by the addition of a chromium-plated moulding extending back almost to the rear of the front door. Chromium instrument bezels brighten the facia, and control knobs that are easier to operate have been introduced.

The Austin Hereford convertible, made by Carbodies, has a power-operated hood. A rotary type door handle and a narrow chromium waist moulding have replaced the rather unusual press type release and wide chromium waist moulding fitted last year. A system of rods and levers transmits the motion of the handle under the door-glass and up again to actuate the latch. Fitted to the new Lanchester Fourteen drop-head coupé, having an alternative de ville position, is the now-familiar Carbodies convertible hood. This, together with the door windows and downward-pivoting rear-quarter windows, is power-operated by an electro-hydraulic system.

Outstanding among the less-expensive categories of convertible cars was the Ford Zephyr, the general style of the saloon being undoubtedly suitable for the conversion. The hood is power-operated, and is controlled by two buttons on the centre of the facia. It is a similar system to that used on the other Carbodies conversions, the Lanchester Fourteen and the Austin Hereford. The hood is raised and lowered by double-acting jacks; a mechanical lock in the jack securing it when in the down position. Another jack behind the centre of the rear seat pushes the squab forward so that the hood can be accommodated easily in the rather small tonneau. This arrangement, as well as economizing in space, serves to warn the rear-seat passengers that the hood is being operated.

When the hood is folded it is covered by a flush-fitting tonneau cover. The back edge of this is held in a groove at the edge of the tonneau by a spring wire, the ends of which locate on studs at the top of each quarter panel. Two clips of heavy gauge wire secure the front extension of the cover just aft of the door.

"A"-shaped radiator grille on the Allard M2X

The hood is made of P.V.C.-covered cotton. This material, it is claimed, has very desirable elastic properties so that it will stretch taut when up, and relax again when folded. Furthermore, it is washable, a very necessary feature when a light-coloured material is employed. The lower edge of the hood at the rear is mounted down inside the tonneau, in a drip channel from which water is drained to the outside of the body. A large curved glass rear window is held in a stiff frame in the hood by a rubber moulding. Separately adjustable seats in the front tilt forward for access to the back seats. The facia, as in the latest Zephyr and Consul models, has a full-width parcel shelf under it. The ignition key has been placed to the right of the steering column and the starter button on the left, an arrangement which leads to a more natural sequence of operation of these controls than was the case in earlier models. The instruments are housed in a pressed-steel, binnacle-type casing above that enclosing the steering column.

No summary of the unusual and outstanding features of the convertible vehicles at the Show would be complete without mention of the rear window of the Jensen Intercepter. This is a thick Perspex panel, curved to the shape of the hood and mounted on the rearmost roof stick. When the hood is up the lower edge of the window bears against a rubber seal on the rear edge of the tonneau into which it drops when folded. Being curved round the rear quarters, in the manner associated with hard-top cars, it furnishes an exceptionally wide range of vision to the rear.

The slender lines of the Jaguar XK120 fixed-head coupé conform unmistakably to the characteristics of a car providing an exceptional performance. An interesting feature of the side lamps fitted into the wings in the same manner as on the saloon, is that wedge-shaped inserts of red glass on top furnish a visual indication to the driver when they are switched on. Superficially, it would appear that the only difference between this model and the open sports type is the saloon canopy. This, however, is not quite the case. Different doors are fitted to

*Continued from page 478.

A.C. Buckland sports tourer with two stick hood

take a drop window, and to support them the front pillar and scuttle structure has been strengthened. A completely reversible, hinged ventilating panel is fitted on each door and the rear quarter lights are of the hinged, extractor type. More room has been provided inside by raising the body slightly, and by forming a slight depression in the floor. The total gain from these two measures is about 2 in.

An unusual feature of the 2-litre Frazer-Nash drophead coupé is the location of the petrol tank on the left side between the front wheel arch and the pillar. Its filler cap at the top of the wing is covered by a plain, hinged flap fitted with an over-centre return spring. The bonnet lid, hinged at the front, is secured at the rear by a centrally placed lock. Unlike some of the other Frazer-Nash cars, there is no bulge on the bonnet top to clear the engine. This is because the higher door line necessary in a convertible body, as compared with the sports version, raises the bonnet line to a higher level. The cant rails are detachable, being fitted only for the purpose of making a draught-proof joint between the windows and the hood. They are peg-located on the windscreen cap, and dovetailed on top of the rear door pillar. On the hood, the head rail hinges back and the top of the front roof stick hinges forward, to clear the squab and rear decking respectively when it is being folded or removed from the tonneau. When erected, the head rail is secured to the screen cap by three toggle clips. Inside this car, due to the greater body width, there is more room for the pedals than in the open sports model.

Of composite construction, the coachwork for the Allard M2X coupé is built by Hilton Bros. All panels, except the steel front wings, are made of aluminium and mounted on an ash framework. The front end is notable for the "A"-shaped radiator grille, and for the close vertical spacing of the head lamps, side lamps, and bumper. On the bonnet top there is an air intake for the fresh-air type Clayton Dewandre heater. The windscreen opening device, made by Worcester Windshields, is interesting. Two roller chains, specially constructed so that they have flexibility in one direction only, are placed back to back and secured at one end to the dash. With the screen open, they form a prop between the dash and the screen lower glazing rail, in the centre of which two rollers are fitted with their axes parallel to the plane of the screen. There is just sufficient clearance for the chains to pass between these rollers. Each chain is bent through 90 deg round the roller to which it is adjacent, and is threaded into the screen rail. A tongued end of a bell-crank lever, mounted on the screen rail, rests on the chain sides which face upwards and engages the rivet heads to prevent the chain from rolling into the rail, thus locking the screen open. To release it, finger pressure is applied to the other end of the bell crank.

The A.C. 2-litre Buckland five-seater sports tourer has a two-stick hood. This, it was found, had cleaner aerodynamic characteristics than a three-stick hood and resulted in less wind noise and flapping of the silk-and-mohair covering. The windows on the doors are made of $\frac{3}{16}$ in Perspex in order that they can bend slightly to conform to the general body shape as they rise in their guide channels. In the top of the doors, the slots are proportioned to provide ample clearance for the Perspex windows and to avoid scratching as they are raised and lowered. A bench-type front seat has two separate, shaped backs of bucket-seat type, which furnish ample support to the shoulders and can be tilted forward to give access to the rear seats. On the steering wheel rim a hide covering is sewn. In the hide-covered facia a circular glove-box opening provides for re-location of the instruments for left-hand drive.

More room has been provided for the two rear passengers in the Morgan four-seater sports car by a re-arrangement of some of the components. The petrol tank is fitted under the floor. One 12-volt battery is mounted under the bonnet to replace the two 6-volt ones in the back of the two-seater version, and one spare wheel is carried instead of two.

There was very little on the specialist coachbuilders' stands that was not described in some detail in last year's Show issue of the *Automobile Engineer*. Hooper's 36 h.p. Daimler gold-plated, touring limousine attracted a great deal of attention and, naturally enough, provoked lively comment. In this country it might not conform to everyone's ideas of tasteful styling, but it is intended for touring in Southern Europe where, in a more exotic environment, it will not appear out of place. What is more, no one could

Morgan Plus Four with full four-seater accommodation

disapprove of the interior appointments, and the whole vehicle is a first-class example of British craftsmanship.

Externally, the car is painted black, with the side panels of the bonnet doors and rear quarters decorated with gold stars in a manner that, in heraldic lore, is termed "Sable Meme of Mullets of Six Points Or." The head lamps are recessed into the wings and are furnished with covers of Perspex, moulded to conform to the wing contour. This arrangement is not new to Hooper and it is stated that experience has shown that these covers do not, as might have been expected, become badly scratched. On the rear wing cover a gold-plated handle, placed horizontally, turns to disclose a lock. A key is used to release the cover which can be swung upwards and outwards on spring-balanced parallel links for access to the wheel. All components, both inside and outside the car, that normally would be chromium-plated, are gold-plated. Double-glazing is fitted at the doors to give better noise insulation, improved thermal insulation and to prevent misting of the windows. All windows and the partition are electrically-operated. De-misting of the Triplex rear window is by means of an electric heating grid, the wires being buried in the plastic centre lamina. The screen is curved to give the best possible range of vision to the front. Over the rear compartment, the roof is fitted with a transparent panel which is covered or exposed by an electrically-operated shutter.

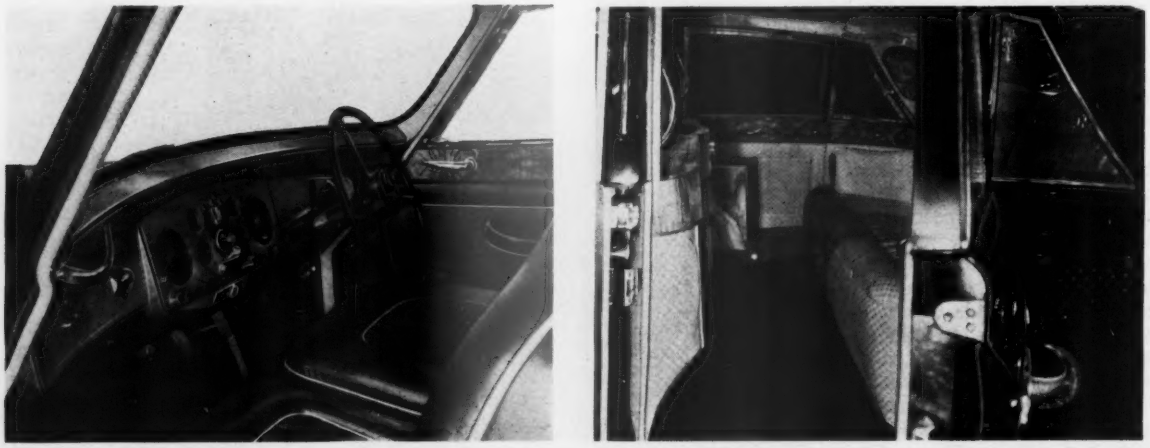
Two separate and independently controlled heaters are fitted, one for the front and the other for the rear compartment. Fresh air is supplied through two ducts in which shutters are incorporated to keep them free from dust when not in use. One of the ducts supplies air to the heater and the other admits cold air for ventilation; a cam-operated valve being used to mix the hot and the cold air. The front heater is supplied with fresh air through the scuttle vent.

Rolls-Royce saloon with division, by Freestone and Webb

The front seats are upholstered with black hide piped with gold, and the rear is in the finest gold silk Carriage Coteline. There is room for three people in the rear and three in the front, the driver's seat being adjustable. Exceptionally beautiful figuring is characteristic of the Australian camphor wood veneer which, mounted on walnut and polished, is used for all cappings and the facia and cabinet work. On the centre of the division is a cocktail cabinet, above which is an eight-day clock mounted on a small compartment for cutlery, crockery and table linen. To the left and right are compartments for glasses and picnic equipment. Two folding tables are fitted, the one on the right having a hinge-over mirror and gold toilet requisites. There are companions in the quarters with polished and veneered shutters. All cabinets are micro-switch illuminated, and reading lamps and concealed lights are fitted in the rear compartment.

Freestone and Webb have, in general changed from the knife-edge to a modified knife-edge style, with somewhat more rounded features. Their Rolls-Royce Silver Wraith four-door, six-light saloon with division, has accommodation for six or seven persons, the front and rear seats being of the one-piece type. In the sliding roof is a Perspex panel with a concealing shutter beneath it, and Purdah sliding glasses at the rear quarters give privacy when desired. The rear-door windows are electrically-operated, and the rear window can be heated. An unusual feature is that the occasional seats fold down, when not in use, to form footrests. The picnic tables each have a mirror, folded behind them, which comes into position ready for use when the tables are lowered. An illuminated cocktail cabinet is fitted to the centre of the division.

Among other exhibits of H. J. Mulliner was a Rolls-Royce Silver



Figured Australian camphor wood is a feature of the interior of the Hooper gold-plated touring limousine on a 36 h.p. Daimler chassis

Wraith touring limousine. The windows are electrically-operated, being controlled by a switch on each door or by a set of master switches on the facia. The drop glass of the division, also electrically-operated, is controlled from the facia or from two alternative switches, one on each side at the rear. Behind the division is a cocktail cabinet, and cubby holes in the doors contain sandwich boxes. An intercommunicating telephone is provided between the front and rear compartments. The assist-pulls are sprung so that they lie flush with the roof when not in use. Under the dash is a trigger mechanism used to release the bonnet that opens automatically. In trays in the dash facia all the tools, except those for wheel-changing, are carried, and a cosmetic tray is provided on the driver's side. The wheel-changing tools are in a compartment adjacent to the spare wheel in the boot.

Lancia Gran Turismo with light alloy bumpers protected by a rubber moulding

The American industry is very much preoccupied with rearmament. Furthermore, it is prevented by trade restrictions from selling its products in this country. As a result it had very little to show that was new. Most stands displayed variations of last year's models, including the now popular hard-top vehicles, some having rear drop windows. Considerable attention has been devoted to providing an all-round range of vision by extending the rear windows around the side until they are separated only by a thin pillar from the door or rear quarter windows. Interior lamps in hard-top models are in some cases being fitted on the waist rails, where there is just room for them between the rear quarter window and the rear window. One example of this feature was seen in the Chevrolet Bel Air.

Interior light in Chevrolet Bel Air

Rockets and guided missiles are prominent among the motifs which are fitted to bonnet tops and in all sorts of unusual places, such as on the front edge of rubbing strips and waist rails. Bumpers and radiator grilles are, in general, somewhat lighter than they were last year, but it is difficult to determine whether this is due to shortage of materials or to changing fashion. It was interesting to note that the seats of one of the exhibits were furnished with woven-plastic loose covers. These, it was stated, were chosen to protect the upholstery at the Show because they were only about one-third the price of the more usual cloth covers.

The exhibits of the Continental manufacturers showed that they, too, favour the horizontal front-end treatment. There is a strong trend to blend the front direction indicating, winking lights into the horizontal lines of the radiator grille. This was particularly noticeable on the Simca Aronde and the Renault Frégate. Perhaps the most remarkable treatment of this feature was on the Ford V-8 Cométe, in which they are mounted in the top of the bumper over-riders, which would seem a somewhat exposed position. Owing to the shortage of materials on the Continent, aluminium has been substituted for chromium-plated steel in many parts. Lancia have gone to the extreme of fitting aluminium alloy bumpers, protected by a narrow rubber moulding, on their Gran-Turismo. Plain bonnet lids are used in many cases, with their releases under the facia.

On the Renault stand, the Frégate was somewhat unusual in that the production models will have seats which can be folded flat on the floor to form a bed, although this feature was not incorporated in the models shown. A well-shrouded facia is incorporated to eliminate reflections at

On the Simca Aronde the winking lights blend into the horizontal grille

night, and the instruments are all mounted behind a single glass panel in front of the driver. The ignition key can be withdrawn with the switch in two alternative positions. In one the steering column, on which the switch is mounted, is locked, and in the other it is left unlocked in case garage staff should require to move the car.

The Ford Cométe was notable principally for the seating arrangements. The rear seat squab is arranged so that the occupants incline to face one another, a feature which makes conversation easier and also comfortably places the feet in the wells in the floor. Unusually large cushions are formed on the front of all the seats to support the thighs.

Several of the Continental cars have door handles fitting flush with the body side. Among these is the Salmson Randonnée, on which the handle forms part of the aluminium waist rail. The piping over the wing crown line, usually made of plastic, is in this car made of aluminium. It is carried across the doors on top of the pressed shape which extends the front wing-line back to blend with the rear wing, over which it is continued to the rear of the car.

Another interesting feature of this car is a polished aluminium drip channel on the roof. At the rear end, in addition to twin rear lamps, a red reflector is mounted on one side to balance a reversing light on the other. Inside the car there are four lights, one on each windscreen pillar and rear-quarter pillar, that are automatically switched on when the doors are opened, and which can be operated individually by separate switches on the lamps. The hinged ventilating panels are unusual in that they are each actuated by a small winding-type regulator, additional to the winder for the drop window.

The head lamps of the Simca Aronde are mounted in rather large chromium-plated bezels. They are wedge-shaped in side view to present a vertical forward face, whilst at the same time fitting snugly on to the front of the wing line as it recedes at the top. The bonnet release in this case is easily accessible through the radiator grille. Louvres in the apron below the front bumper deflect air on to the brake drums. On each rear lamp is a polished aluminium hood, the left-hand one forming the petrol filler cover. Being hinged and fitted with a return spring at its front end, it is opened by lifting at the rear.

On the facia, above the steering column, is fitted a semi-circular Jaeger instrument of the binnacle type. This is the only instrument,

Petrol filler incorporated with rear lamp fitting on the Simca Aronde

its main feature being a speedometer the pointer of which pivots about the centre of the base, at which point a trip indicator is placed. Around the periphery, from left to right, are a petrol gauge, reserve petrol warning light, a charging indicator light, and an oil pressure gauge. Opposite the passenger, two glove boxes are fitted, one each side of a deep, pull-out ashtray. At each side of a glove box are hinges, positioned well inside in such a manner that the lid rolls up almost out of sight under the top of the facia.

Of aerodynamic design, the Porsche fixed and drop-head coupés, it is claimed, have been extensively and accurately developed from wind-tunnel tests. The manufacturers state that a top speed of 90 m.p.h. is attainable, the engine developing 44 b.h.p. and the dry weight of the car being 15 cwt. Luggage space is always a problem in rear-engined cars, and in this case it is stowed behind the two front seats. These are separately adjustable, both for angle and fore-and-aft location. Housed under the bonnet are the spare wheel, the battery and the petrol tank. The windscreen shape has been specially developed to prevent distorted vision. It is of V-shape with a centre pillar, each panel being almost flat near the centre, and curving with a decreasing radius towards the thin side pillar.

Weight-saving has been studied very carefully on the Ferrari. For this reason shrouds are fitted over the bumper irons of the 2·6-litre sports model instead of the more usual aprons, and even the window regulator levers are slotted over their length. On the 4·1-litre model an ignition warning-light is mounted in the centre of the starter button. Another rather unusual feature of these two vehicles is that an electric heater element is fitted in the two screen de-misting slots, which are supplied with air from the front of the bonnet. The air ducts are formed in the front valances which are fabricated from two pieces, the horizontal junctions of which are suitably arranged so as to form an enclosed section for this purpose.

The Alfa-Romeo 1900 saloon was introduced at the 1950 Paris Salon,

Aerodynamic lines of the new Porsche two-seater coupé

but it was shown at Earl's Court for the first time this year. Four versions were exhibited, differing only in their colour schemes. The front apron is dispensed with by shaping the bumper to fit the front-end contours of the body. Slab sides of a substantially elliptical form, with long sweeping curves, are characteristic of this car. Attractively curved features are also to be found in the rather unusual radiator grille arrangement. A central vertical grille is flanked on each side by a horizontal grille of similar shape and size to produce a distinctive trefoil design.

RECENT PUBLICATIONS

Brief Reviews of Current Technical Books

Servicing Guide to British Motor Vehicles

By J. N. McHattie, A.M.I.Mech.E., M.S.A.E.

London: Published for *Motor Trader* and *British Automobiles Overseas* by TRADER PUBLISHER CO. LTD., Dorset House, Stamford Street, S.E.1. 1951. 8¾×11¼. 428 pp. Price 63s.

Collected in one volume for the use of those engaged in maintenance or repair, and also for the student of design, are 8-page service data sheets and descriptive matter relating to fifty-two types of vehicle. An enormous amount of information is presented systematically and no effort has been spared to facilitate ready reference or comparison of the different vehicles. In each description the same tem appears under the same heading and, as nearly as possible, in the same place on the page. Not only do the headings and sub-headings follow a standard sequence; even the order of paragraphs and sentences, the form of tables, and the style of illustrations show close attention to uniformity. Such consistency of presentation for a wide range of vehicles of different manufacturers could be obtained only under the close supervision of a single compiling authority.

All the information required for routine maintenance of a particular vehicle is gathered together on one page of each section, including a maintenance diagram and a table of recommended lubricants. On another page is an electrical wiring diagram. Vehicles are grouped according to make, and a thumb-indexed division card with a list of contents is provided for each group.

An introduction in three languages, English, French and Spanish, is followed by an illustrated glossary of terms. A most useful list of alternative names of component parts is given; the terms selected for the book being picked out in bold type. In the appendix are conversion factors and tables for British, American and Continental units. These cover specific fuel consumption, torque and capacity, as well as primary units. British lubricating oils are tabulated in equivalent S.A.E. viscosity numbers.

The service sheets cover, broadly, the post war period up to 1950, though some models of the immediate pre-war period are included and, naturally, some models in current production are absent. Intended for frequent reference, the volume is designed and produced to withstand hard usage. The paper is claimed to be the strongest available and the stout board covers are protected by a cloth impervious to water and grease.

Modern Coach and Motor Trimming

By J. D. McLintock.

London: THE TECHNICAL PRESS LTD., Gloucester Rd., Kingston Hill, Surrey. 1951. 92 pp. 5½×8¾. Price 10s. 6d.

The subject of trimming for coaches and motor cars seems to have been dealt with very rarely in the technical literature of the trade. It is, however, a subject which cannot continue to be thus ignored, for the part played by the trimming in enhancing or detracting from the comfort, appearance and value of vehicles is of importance and merits attention.

The author states that he had two objects in preparing this book: first, to give a brief outline of the fashions and methods in this branch of the industry from the earliest days, and secondly to set out simple instructions and general advice for the execution of certain examples of the work. The fashion trends are dealt with very briefly but provide sufficient information to give a general picture of the subject. The introduction devoted to trimming technique, differentiates between mass and individual production, and a chapter is later devoted to methods for the mass-produced car. The practical aspect of trimming hand-made bodywork can still involve the employment of highly skilled craftsmen, who are few in number and have little, if any, literature to guide them.

By far the greater part of the book, however, is concerned with actual instructions for the work. Information is given as to the tools necessary and the materials used for coverings and fillings, with special notes on rubber fillings. Seats, squabs, doors, hoods and sidescreens are all dealt with.

Step-by-step instructions, with measurements, are given in many cases, and styles, materials and techniques are discussed helpfully. Important items such as sewing machines and adhesives each have a separate chapter. There are many illustrations of tools and how they are used, including useful sectional illustrations of upholstered parts. The addition of a few diagrams showing the cutting and marking of materials for such items as fluted coverings for seats and squabs should have been included to accompany the written instructions, despite the fact that these are very carefully detailed.

Intended as a guide for apprentices and amateurs in this work, the book will also serve as a useful reference for the professional trimmer. Much valuable information has been gathered by the author, and his work should certainly not be missing from the shelves of those concerned in any way with this branch of car production.

The Autocar Road Tests, 1951

London: ILIFFE & SONS LTD., Dorset House, Stamford Street, E.C.1. 1951. 8½×11½. 96pp. Price 5s.

Every reader of *The Autocar* will be conversant with that journal's road tests of currently produced cars. They include illustrations of the vehicle, details of performance over hundreds of miles of driving, and information that is of interest to potential owners. These reports have lost little of their appeal despite the reduction in the number of cars available on the home market.

Here is an opportunity to buy the reports of all the road tests made during the last twelve months, bound together in a book and prefaced with a foreword, by *The Autocar's* Technical Editor, on how the tests are made. Thirty tests are included and all but three relate to British motor cars of various sizes, types and prices. For those not familiar with these test reports, it may be stated that technical information is given concerning h.p., weight and principal dimensions, and an average of about a thousand words on the performance of each car. They are written by those who conducted the tests, under normal driving conditions on typical British give-and-take roads and through traffic. Mechanical details are given as well as points of interest to the owner driver, such as ease of access, driving position, handling and maximum touring speeds. They are well illustrated and include line drawings showing interior dimensions of the vehicles.

An Introduction to the Theory of Control in Mechanical Engineering

By R. H. Macmillan.

London: CAMBRIDGE UNIVERSITY PRESS, 200 Euston Road, N.W.1. 1951. 7×10¼. 195 pp. Price 30s.

The wealth of technical literature published in recent years might be expected to cover every phase and branch of every known subject, and indeed it does except for a few isolated cases and remote or narrow subjects. This book, however, is concerned with one of the exceptions and deals with a subject that, although it might be considered by the layman to be highly specialized, is becoming very important to productivity. The subject may have been treated by authors outside Great Britain, particularly with reference to servo-mechanisms, but this is the first British book dealing with the basic principles that underlie the action of every kind of automatic control employed in mechanical engineering. Although this book does not discuss non-mechanical control systems in any detail (it was not intended to do so), the author says "even economic controls and the control of infectious diseases are subject to the same laws and equations as are mechanical systems". Bearing this in mind, the reader realizes that this subject affects his daily life more than he would have expected.

The author has given more examples of mechanical control systems than of electrical ones, because what papers have been published on the subject have tended to refer mostly to the electrical mechanisms.

The book will probably be of greater interest to the student and physicist than to the designer, but the latter will find it of value if he does not expect to find fully worked-out details of specific applications. It covers methods, principles, and the philisophy of control. The designer will also benefit from the author's mathematical analysis of control systems, which is essential in order to find the best possible controller with a high standard of performance for any specific job.

Basic concepts of control are first introduced and later, the essential components of control systems are considered in detail. The study of these components—hydraulic equipment, transmission links, mechanical power amplifiers, variable speed gears—includes the significance of a transfer function of these and more complex components. The selection of equations for typical control systems is described, preparatory to the consideration of

quantitative analysis of performance. Harmonic and transient responses are each dealt with and some new ideas of feed-back and order of control are included.

Knowledge of the above prepares the reader for consideration of servo theory, loop and overall transfer functions, etc. The use of complex numbers and also the Laplace transformation for solving more complicated governing equations form subjects for two Appendices, and these will be welcomed by students. Not all chapters use these methods, however, so the book should be understandable by any engineer or physicist who can solve simple linear differential equations with constant coefficients. Even this may not be necessary if the reader does not wish to follow the working.

Analytical methods are used for determining a criterion of stability for the more complex equations but, for purposes of design, graphical procedures depending on the Nyquist Diagram are used. A valuable bibliography is included and each chapter concludes with a number of examples, some of which are taken from Mechanical Science Tripos Papers. Unfortunately, however, no answers are given to the numerical questions, and the value of a book of this kind to the students is always enhanced if he knows whether he has worked these examples correctly.

Your Factory and the Law

By Francis W. Hunt, B.Sc.

London: SEVEN OAKS PRESS LTD., 165 Victoria St., S.W.1. 1951. 156 pp. $5\frac{1}{2} \times 8\frac{3}{4}$. Price 15s.

The requirements of the Factories Acts today are numerous, and the wide range may appear disconcerting to executives whose responsibility it is to ensure that the various regulations are complied with. In his book, Mr. Hunt brings forty years' experience as one of H.M. Inspectors of Factories to bear upon the Factories Acts, 1937 and 1948, and the result is a concise summary of the provisions of the Acts, grouped in such a way as to be easily followed by everyone, and couched in a language that is far removed from obscure legal jargon.

The author begins by defining the meaning of the word "Factory", and the rest of the book is devoted to chapters dealing with various subjects covered by the Acts. The main points to be observed in connection with Construction, Amenities, Cleanliness, Ventilation, Health, Dangerous Materials and Processes, Welfare, Safety, Employment, Piecework, Applications of the Act, Duties of Occupiers and Owners, and Administration are brought together under the appropriate headings. Each chapter deals with its subject briefly, but with enough detail to give a clear idea of what is required, and the chapters are divided into sections under appropriate headings, so that any point is found with the minimum of search. The question of Safety, for example, has three chapters devoted to it, under the headings "Fencing", "Special Plant" and "Miscellaneous Provisions", and the first of these chapters is subdivided under the headings "Prime Movers", "Other Machinery", "Transmission Machinery", "Dangerous Parts", "New Machinery", "Vessels Containing Dangerous Liquids" etc., etc.

It will be seen that the range of the book is wide, but the grouping of subjects is such that it does not bewilder. The author has carefully selected all the most important regulations, and his experience helps him to pick out the points which need extra comment on his part to clarify the position.

Such an extensive subject, of course, can only be dealt with in outline in a small book, and while it is comprehensive enough for most cases, any desired reference to the Acts themselves is facilitated by means of marginal notes giving the Sections concerned. The limits of the book also make it impossible to give all the various Regulations, Orders, Exemptions etc. remaining in force or made under other Acts, and here again references to "Factory Orders" are given in marginal notes where necessary.

This book will be found a most valuable time-saver. An index enables appropriate sections to be found at once, and the language is straight-forward enough to be readily understood at the first cursory reading.

Stampi E Presse (Dies and Presses)

By Aldo Berutti.

Turin: S. LATTES & Co., 3, Via Garibaldi. 1951. 481 pp. $6\frac{1}{4} \times 9\frac{1}{2}$. Price Lire 3,400.

The best compliment that can be paid to this book is to say there should be an English translation. Users of presses and dies "for Sheet Metal Cold Working" (to give the book its full title) would certainly be glad to study it. The author is one of the managers of the firm Fiat-Mirafiori, and the subject is one upon which he is an authority.

The book follows the gradual development of successive operations from the early stages of design in the drawing office, to the preparation of the dies in the tool-room, the setting-up in the test room and the production workshops, and the manufacture of the produced parts. Much is included on the presses themselves, their method of working and installations comprising complex operating plant.

Probably the most valuable part of the work is the clearly reproduced drawings, working sectional drawings and illustration of presses in perspective. These follow the development of the text and make the material interesting and understandable to the less highly technical reader. Workshop organization is discussed with a view to elimination of accidents in the press shop. The author also criticizes some methods and equipment, whilst giving his views on future development of presses and dies.

Fractional Horse Power Motors

By Stuart F. Philpott, M.I.E.E., F.B.H.I.

London: CHAPMAN AND HALL, LTD., 37, Essex St., W.C.2. 1951. $5\frac{1}{2} \times 8\frac{1}{2}$. 367 pp. Price 30s.

Probably the greatest proportion of electric motors now manufactured, are of less than one h.p. Domestic equipment, such as vacuum cleaners, electric razors, hair dryers, sewing machines, clocks, gramophones, washing machines, refrigerators, fans, etc., account for many thousands in each class. There are also the numerous small tools used in general engineering, particularly portable ones such as small grinding and drilling machines. These motors are expected to give foolproof service for many years with little or no attention. In fact, many of them are now fitted with self-lubricating bushes and they need no further lubrication or other attention. They are often fitted and forgotten.

This book is valuable for those who fit fractional horse power motors in any quantities, for those who manufacture the motors themselves or any parts of them, and for those who have to maintain or repair them. Briefly, the subject matter includes the principles, operating characteristics, construction, application, use, and maintenance of every type of small motor. About one half of the book covers the practical considerations of the principal types under such headings as D.C. Motors, Universal Motors, Polyphase Induction Motors, Shaded-Pole Motors, Split-Phase Motors, Capacitor Motors, Repulsion Motors, and Synchronous Motors. Some basic electrical knowledge is of course required and it is doubtful if anyone not electrically trained, would wish to read the book. The author does not, however, delve deeply into electric motor theory.

The selection of motors to suit various applications brings out many points in design, and a chapter is devoted to these features of the various types. A very useful chapter is that on radio interference suppression, which is now becoming increasingly important in view of the sale of television sets. The chapter on testing, is also of practical importance and covers a brake test, a starting torque test, a heat run to determine temperature rise, and an insulation test.

Transport Goods Guide July-December, 1951

London: ILIFFE & SONS LTD., Dorset House, Stamford St., S.E.1. $8 \times 11\frac{1}{4}$. 120 pp. Price 2s. 6d.

Covering all methods of transport within England, Scotland and Wales, i.e. road, rail, air, canal and sea, this up-to-date edition provides the transport manager of any industry with all the information he requires on available transport for hire. It includes an A.B.C. of transport services, giving details of all available road services, district-by-district and, generally, town-by-town. In addition it lists all machinery carriers with low loaders, the tank wagon operators, the ferries (with times of first and last services), shipping services, London public wharfingers and public warehouse keepers. Some valuable information concerning goods sent by air, includes maximum payloads and the sizes of doors or hatches.

Details of the remaining independent hauliers and the goods they carry are given, and these are correct up to date of publication. This information provides most of the alterations in this new edition, and includes small operators and local carriers. This edition will be just as popular and as useful as preceding ones; it is invaluable for anyone who may have to buy or hire outside transport of any kind.

British Standards Institution Yearbook, 1951

London: BRITISH STANDARDS INSTITUTION, 24 Victoria St., S.W.1. 1951. $5\frac{1}{4} \times 8\frac{1}{4}$. 399 pp. Price 7s. 6d.

The work of this important Institution up to 31st. December, 1950 is contained in this yearbook and all British Standards up to that date are listed and very briefly described. In addition the memberships of all the main Committees are included and, as the reader may know, these Committees cover a very wide range of industrial products from builders' Plant to Scientific Glassware and from Proofed Clothing to Pest Control. A subject index is appended, and this will possibly constitute the most important reason why the book will be regarded as a necessary reference volume by a very varied cross sect ion of industrial executives.

THE R.F. GREEN LINE COACH

One Basic Body Structure for all L.T.E. Single-deck Vehicles

A NEW Green Line coach of improved design is to replace existing vehicles. An outstanding feature of the design is that the basic structure is the same for all the London Transport Executive's single-deck buses and coaches, listed in the accompanying table, except for the Private Hire vehicles, and even in these it is the same forward of the rear wheels. Such a high degree of standardization is very desirable from the point of view of maintenance and to ensure that, as far as possible, spare parts are common to all the four types of vehicle. The fulfilment of these requirements, together with the fact that a marked improvement on the old models has been effected, reflects considerable credit on the designers.

The general layout and specification of the coachwork was prepared at the Chiswick Offices of the London Transport Executive. The design was then passed to Metropolitan-Cammell-Weyman, at Elmdon, to do the detail design and construction. Douglas Scott and Norbert Dutton were consulted in the early stages by the L.T.E. on the subject of styling. The final product is the result of close co-operation between manufacturers, operators, and stylists, and comprehensive integration of all points of view has achieved a good design.

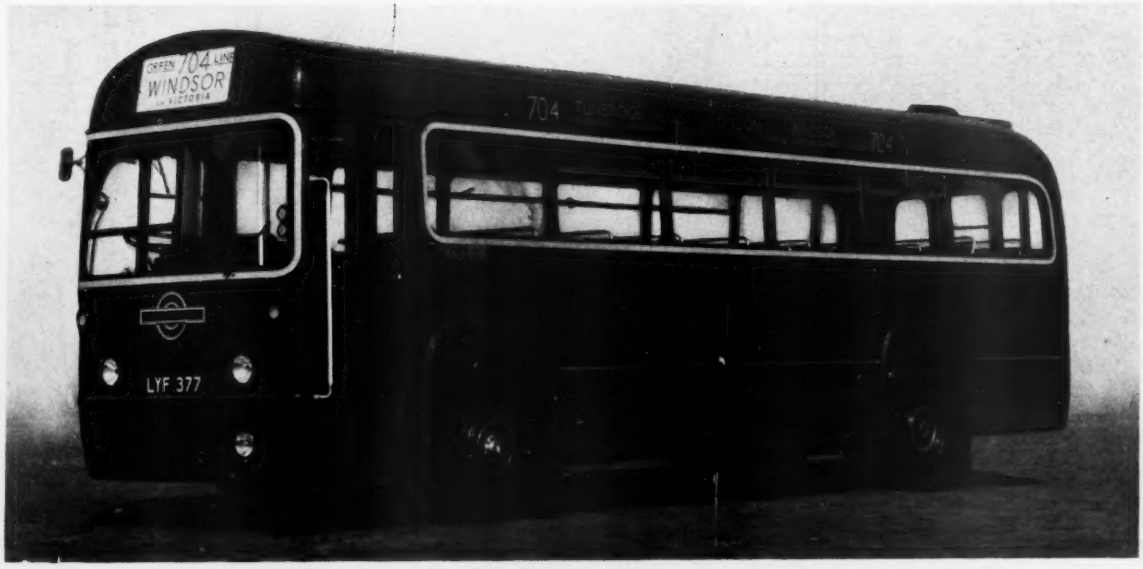
The chassis chosen as the basis of all these replacements is the A.E.C. Regal MK IV, described in the April, 1950, issue of the *Automobile Engineer*. This flat-topped chassis with an underfloor engine is particularly suited to passenger-carrying vehicles. It permits the arrangement of the driver's cab so that an excellent range of vision, including a view of the passenger's entrance is obtained. Furthermore, the positioning of the door right at the front of the body becomes possible as the engine and radiator are under the floor and the front wheels have been moved an appropriate distance rearwards. This axle disposition has the additional advantage of providing a better weight distribution over the wheelbase, and hence a better ride. The power unit is the relatively quiet-running 125 b.h.p. A.E.C. diesel engine, removal of which is facilitated by a screw-jack on the frame.

Although the chassis is self-sufficient as far as strength is concerned and carries all the essential component units, the body is of stressed-skin construction. This arrangement provides a much greater measure of overall stiffness than hitherto, with a resultant improvement in the stability of the ride. Eight outrigger brackets from the frame carry the body, one in front and one behind each wheel, and additional support is afforded by the front cross member of the chassis.

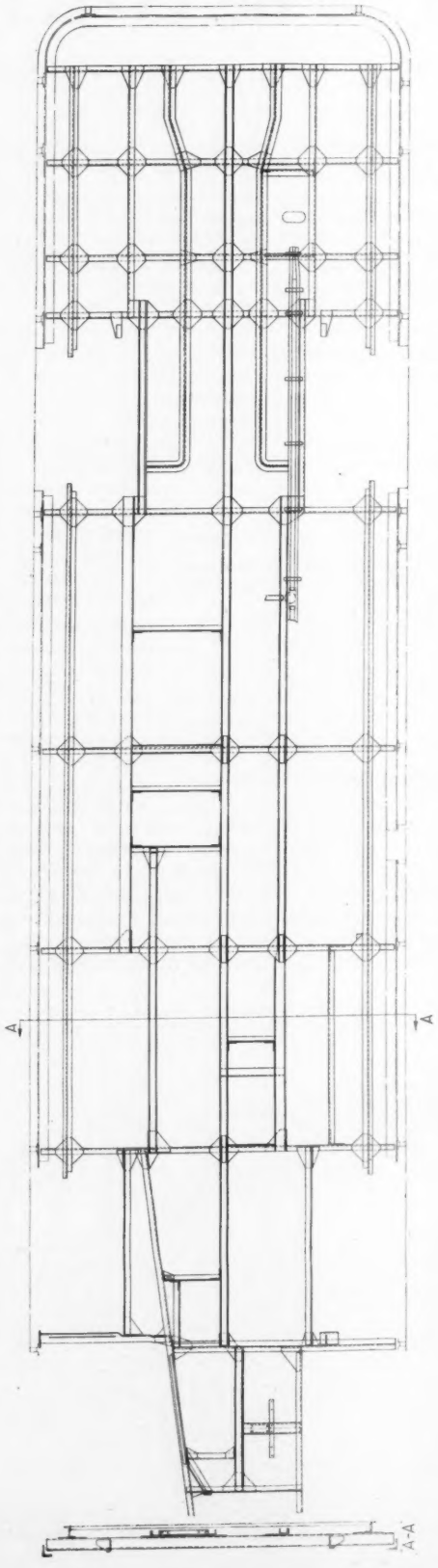
The method of mounting the body is unusual in that a riveted junction is made between the body and the chassis. Separation of the units would, therefore, not be easy but it has the advantage that squeaking and general loss of stiffness, arising when body-mounting bolts work loose, is obviated. The principle of permanent assembly is made practical by virtue of the fact that the L.T.E. have a roll-over rig in their overhaul department to support the vehicle on its side for the cleaning, repair, or removal of mechanical units mounted

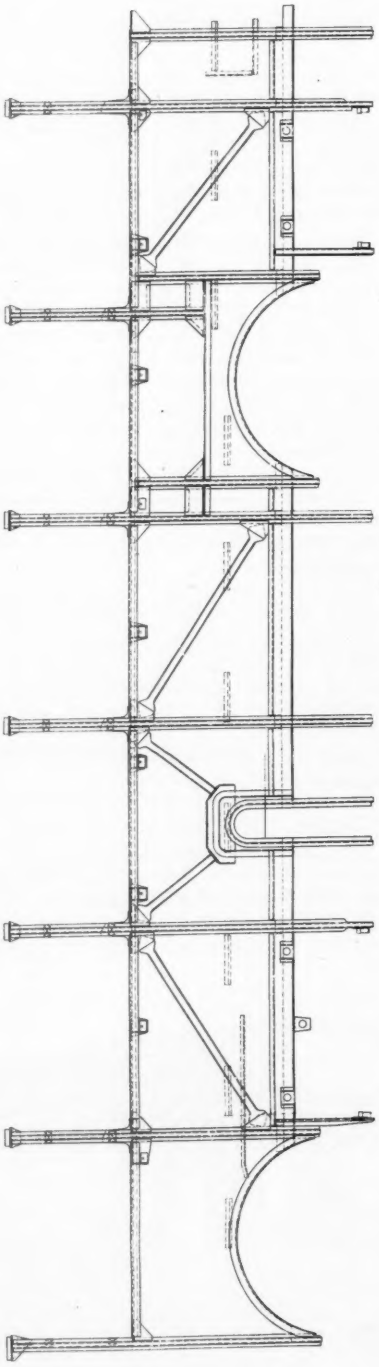
L.T.E. SINGLE-DECK VEHICLES

Vehicles	Number to be built	Overall length	Overall width	Seating capacity
Private Hire coaches ..	25	27 ft 6 in	7 ft 6 in	35
Green Line coaches ..	263	30 ft 6 in	„ „	39
Central single-deck buses	225	„ „	„ „	41
Country single-deck buses	187	„ „	„ „	41



Green Line coach with Glider doors, and high-level, half-drop windows



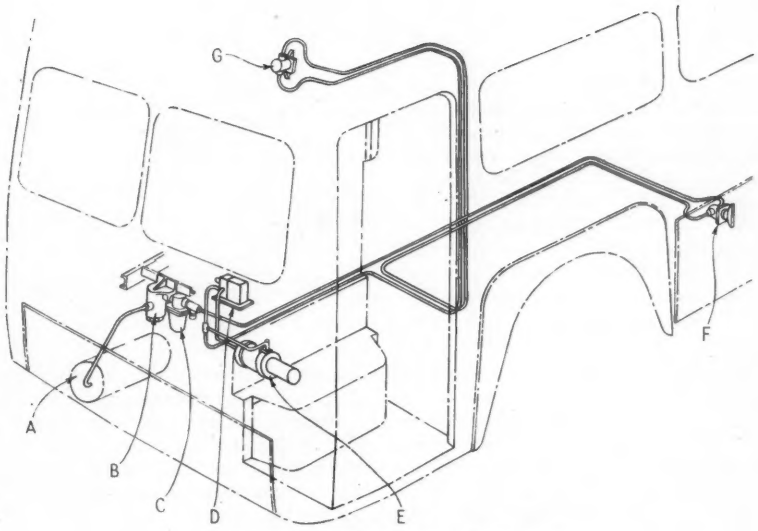


BODY FLOOR AND SIDE STRUCTURE OF R.F. GREEN LINE COACH

under the body floor.

This rig comprises a cradle in which the vehicle is secured; the height of the attachments being adjustable by means of screw jacks. The cradle consists of three large, semi-circular frames stationed vertically, one at the centre and one at each end of the vehicle. These frames are supported on rollers, so that they can be rotated through approximately 90 deg about an axis through their own geometric centres, until the vehicle is in such a position relative to the ground that servicing is facilitated. In this position, additional support for the vehicle is furnished by screw-jack fittings, one on each frame. These are adjusted, prior to the roll-over operation, to bear against the sides of the vehicle. Power for the rotation of the cradle is transmitted by a shaft from a single electric motor to a sprocket-and-chain arrangement on the periphery of each frame.

In this way the time usually expended in removing the body from the chassis for routine repair and overhaul is saved, more people can be employed simultaneously on the underside, and the working position is more convenient than that in a pit. Simplification of the maintenance routine by the use of this equipment might well become more general among operators of large fleets of transport vehicles, and it is worthy of serious consideration in connection with vehicles for the armed forces.



Compressed air system for the Glider doors

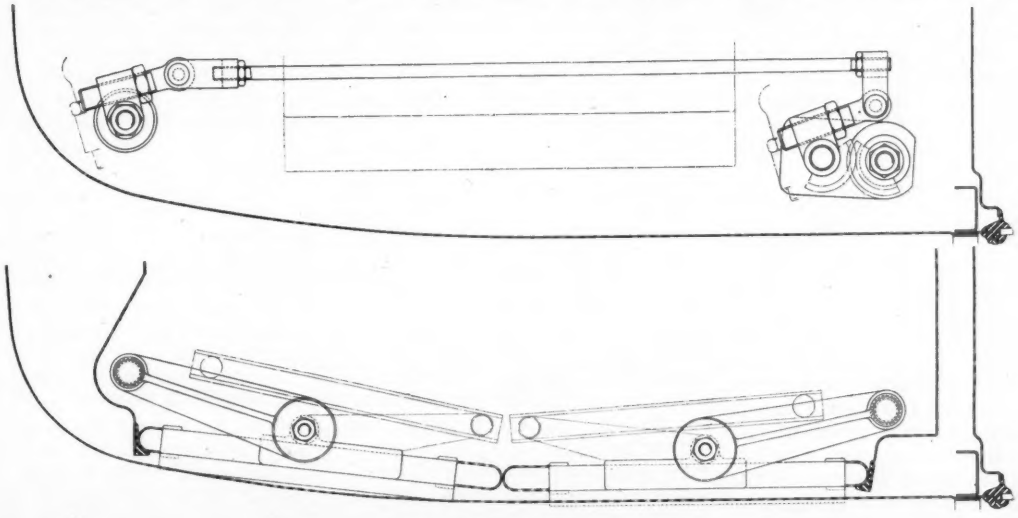
A Chassis air-pressure reservoir
B Air filter
C Reducing valve
D Electro-pneumatic valve
E Door operating jack
F Outside emergency air-release tap
G Inside emergency air-release tap

Main body structure

The floor is mounted $5\frac{13}{16}$ in clear of the chassis frame to reduce the obstruction caused by the wheelarches. These are specified as being made of 20 B.G. Firth-Vickers F.S.L. Stay-bright steel, but in view of the current shortage of materials this, together with some of the other specifications, is liable to be changed temporarily. Four B.S.S. 5007/405 nickel-steel cross bearers, situated one in front and one behind each pair of wheels, carry the floor on the body mounting brackets. All the cross bearers, except the front one, which is of Z-section, are of channel section, $2\frac{1}{2}$ in deep, $1\frac{1}{4}$ in flanges and $\frac{1}{8}$ in thick.

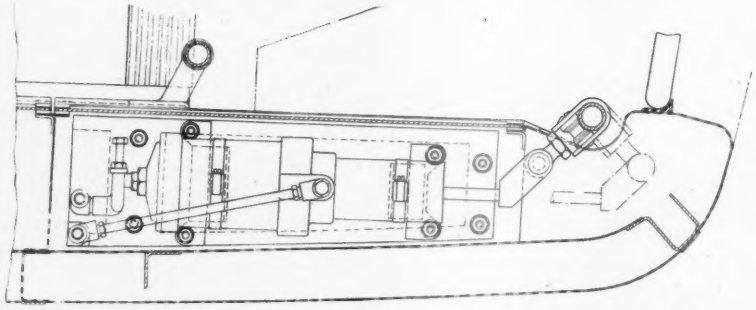
Additional support for the floor is furnished by two more channel-section cross members, of the same material and dimensions positioned within the wheelbase, and by three mild steel, channel-section members, $3\frac{13}{16}$ in deep, at the rear. Gusseted to the top of these lateral members are five longitudinal floor members in 14 B.G. mild steel. These comprise three channels spaced to furnish support for most of the floor area, and two Z-sections, one at each side of the body, to which are attached the fillet and the heater duct respectively.

Mild steel pressed sections are used to brace the body sides in a conventional manner. Metropolitan-Cammell-Weyman pillar sections are used. These are made from an 18 S.W.G. mild steel tube manipulated to a shape resembling a shallow top hat fitted into a deeper one; the overall dimensions being $2\frac{3}{4}$ in wide over the flanges and $1\frac{7}{8}$ in deep. The longitudinals at the waist rail and floor



Door-operating gear

above: Interconnecting mechanism for the two door-operating spindles
below: Door-leaf operating levers



A pneumatic jack operates the doors through a lever on a vertical spindle

level, as well as the diagonal and incidental bracing members, are all of 14 S.W.G. mild steel channel section.

This framework supports the inner and outer skins. The inner one is a stressed panel made of 16 S.W.G. BS 1470 NS 4 aluminium alloy. Solid rivets are used to secure sections covering two bays to the structure. The outer panel, of 18 S.W.G. half-hard, commercial grade aluminium sheet, is secured to the bracing frame by Tucker POP rivets, the bores of which are filled with Prestik to prevent ingress of water. Lapped vertical joints are formed on the outer panels, while on the inner ones butt joints are used. The front and rear ends of the body are constructed on the same principle as the sides, but an emergency door is incorporated in the back.

Formed of Z-section members, the upper structure consists of 16 S.W.G. mild steel roof sticks, $1\frac{3}{4}$ in deep and $\frac{7}{8}$ in flange, to which are gusseted the longitudinals and the 14 S.W.G. cant rails. Double skinning is employed, as on the body sides, but the inner skin is of 4·5 mm plywood except behind the luggage racks where it is of aluminium protected from damage inside by Traffolyte plastic panels manufactured by De La Rue.

The complete body framework is first assembled and brushed with Carbolastic, the steel parts having been previously rust-proofed by a phosphate process and stove enamelled. Then the primed skin panels are riveted on, the outer ones being brush painted and varnished in the last stages of the assembly process. All detachable panels, however, are stove enamelled to give a finish that will withstand hard treatment and repeated handling.

The driver sits in the usual position, on the right side at the front, within the main passenger compartment. He is protected from interference by passengers by a rear screen which is extended forward on his left side for abour 13 in. Another screen, mounted at his left front, is set at an angle such that it presents only its edge to interfere with his range of vision. It is free from glass to avoid reflections at night. On it is hinged a waist-high door that opens on to the platform and is the only means of access to the seat. Blinds can be drawn to cover the glazed upper portion of the rear screen and also the opening above the driver's door. On the right side a vertically sliding window is provided for hand signalling to supplement the use of the usual trafficators.

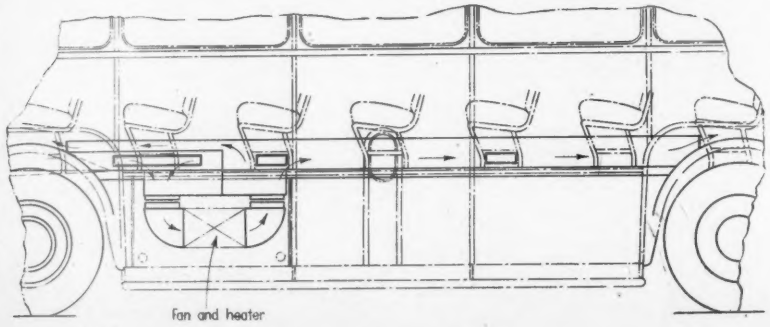
The opening-type Triplex laminated windscreen is set back and hinged at the top. Its angle in the closed position is 20 deg from the vertical to prevent reflections from the interior at night. Twin wipers, operated by flexible drives from C.A.V. electric units, are fitted, one in the cab and the other at the lower edge of the conductor's front windscreen. In the front of the canopy above the driver is the engine air intake which passes through a Burgess silencer mounted in the cab roof on the right side. From this position, where the air is reasonably free from dust, a duct carries the air behind the driver and down to the engine.

Passenger access doors

The G.D. Peters electro-pneumatic Glider doors, which will be fitted to all models except the Central single-deck buses, are a noteworthy feature of the design. Situated at the extreme left front of the vehicle, they have a quick, smooth action whilst providing a full aperture without intruding on the conductor's platform and occupy a minimum amount of space. Four glazed panels cover almost the whole of the two door leaves, giving both the driver and the conductor a view of even the smallest passengers wishing to gain entrance. Having no locks, hinges, or other large fittings within the panels, the two thin door leaves are of very light construction. Large rubber seals prevent draughts, and permit ample manufacturing tolerances to be used without any risk of either jamming or faulty closure. Furthermore, they eliminate the danger of trapping and injuring passengers' hands. Two push-button electric controls for the pneumatic door operating system are fitted, one in the driver's compartment and the other adjacent to the door.

Operation of the doors is by means of a pneumatic cylinder, mounted on the front of the body framework below the waist, which actuates a lever attached to a vertical tubular spindle. Levers are attached to each end of the spindle, their ends being trunnion-mounted adjacent to the centre of the upper and lower edges of the front door leaf. At the rear edge of the door opening, another vertical spindle carries the rear door on levers in a similar manner, but it is operated by a connecting rod passing over the door from a lever on the front spindle. The direction of the rotation of the rear spindle relative to that of the front one, is reversed by two inter-meshing, toothed quadrants through which the motion of the connecting rod is transmitted to the upper end of the rear spindle.

Bolted to the top of each door leaf is another lever, its end being engaged in a guide channel. These guide channels are so arranged that each turns its respective door leaf through approximately 90 deg about its trunnion-mounted support levers as they swing the leaves inwards to open the door. The edge of the front leaf that, in the closed position, abuts the forward margin of the aperture is adjacent to the heel of the step when moved to the open position, and the rear edge of this leaf then bears against the



Recirculating heating system

aperture margin. Simultaneously, the rear leaf turns in a similar manner so that its rear edge is adjacent to the heel of the step and its front edge is against the rear margin of the aperture. The operating rods and levers have screwed ends for adjustment and are secured with the usual locknuts. Emergency operation by hand is possible by means of two red-painted and labelled air release taps, one inside and the other outside, in prominent positions close to the door.

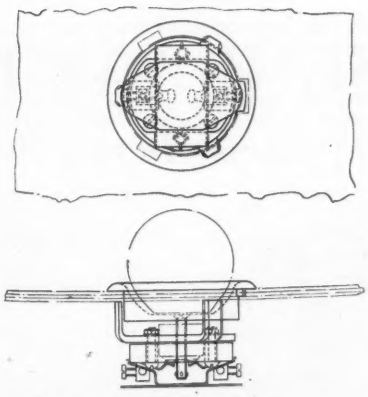
Interior equipment

In the coaches all seats face forward except the single one immediately to the rear of the driver's compartment, which is placed against the side of the vehicle, and faces inwards. All seat squabs, being of the usual L.T.E. design, are easily removed without using tools. Naturally, the seating is arranged differently in the buses so as to give more room for standing passengers, and for the conductor to collect his fares.

Dunlopillo is used throughout for squabs and seats and trimming is done with moquette, in a small square design of predominantly green colour. In the coaches the luggage racks are fitted with polished Mg. 7 aluminium alloy hand-rails along their full length. The hand-rails can be removed in sections 7 ft 10 in long for easy maintenance. This is a great improvement on older installations in which the whole of the rail and luggage rack had to be removed for this purpose.

Eight high-level, half-drop windows are fitted, four on each side of the vehicle, and are operated by a winding mechanism that restricts the opening to about 5½ in. The winding mechanism, housed in the stainless steel top glazing frame of the fixed lower portion, is above eye-level, and the lower edge of the opening pane has no glazing rail. This arrangement ensures an unrestricted range of vision for the passengers whether the windows are open or closed. Even on the hottest day, it is claimed, these windows provide ample ventilation if they are all open, and less draught is experienced with them than with the full-drop type. Except for the windscreen and two emergency exit windows, one on each side, 32-oz toughened glass is used throughout.

A well-lagged V.25/4 Clayton Dewandre re-circulating heater is fitted under the floor of the left side, the main air duct being on the floor on the same side. Air drawn by the fan through a single large grille in the side of this duct at the forward end, is passed through the heater matrix and then expelled through smaller outlet grilles spaced along the duct. In the side of the large elbow, connecting the intake portion of the main duct with the heater, a hinged panel permits the withdrawal of the fan unit for servicing. In the driver's compartment a separate C.B. 28 Clayton Dewandre heater is used in conjunction with a de-misting system designed by the L.T.E., fitted to the top of the lower windscreen glass. Two extractor ventilators are mounted on the rear of the roof, and it is now proposed to fit a third intake-type near the centre.



Quick-detachable interior lamp unit

Electrical equipment and detail exterior fittings

An electrical control panel is situated for convenience of access, behind the squab of the sideways facing front seat. C.A.V. sealed-beam, pre-focused headlamps are fitted. The beam of the right one is so adjusted that it strikes the ground 100 ft straight ahead of the vehicle, and it is switched out when the dipping switch is operated. The beam of the left one is directed at a greater angle downwards, and towards the kerb. The side lamps are installed above the headlamps and a C.A.V. sealed beam, pre-focused foglamp, adjustable by the driver, is situated below the left one. A rear ruby and amber stop light, together with two direction arrows, are incorporated above the number-plate. In the doorway two lights are fitted, one on the riser of each entrance step. Diffused interior lighting is furnished by thirty 12-watt, 24-volt, pearl lamps, with concealed bezel-fittings, well-spaced on the under side of the luggage racks and along the centre of the roof. The lamp holder assemblies are mounted on pressed brass spiders above the panel. By turning the fitting the legs of the spider are aligned with slots in the circumference of the hole in the panel in which the bezel fitting is mounted and the whole unit, complete with its electrical connections can be withdrawn.

Detachable panels are fitted for access to the engine, heater, and the batteries. Mounted behind the rear left wheel, the batteries are in a cradle furnished with a gate for servicing. Although the fuel filler cap on the left side is very accessible, a detachable panel is fitted under it to facilitate removal of the tank without resorting to the use of a pit. Inverted U-fittings on the lower edge of all these panels engage on a peg. Removal is effected by undoing two quick-release screws at the top, with a coin if no screwdriver is available, and lifting the panel so that the U-fitting is clear of the pegs. Should the screws come undone accidentally the arrangement of the lower fitting is such that the panel cannot pivot more than about 20 deg outwards. This reduces the risk of accidents to pedestrians or other road users if a panel becomes loose while the vehicle is in motion. In addition, removable panels are superior to hinged ones which cannot be fully opened in tightly packed garages.

Dexion Angle

THIS slotted angle is supplied to both home and overseas markets in standard 10-ft lengths of 12 S.W.G. aluminium alloy and for export only in 14 S.W.G. rust-proofed steel. Its principal advantages lie in its adaptability for various constructional purposes, and the ease with which it can be erected or dismantled by unskilled labour using only nuts and bolts, a spanner and a hacksaw. In large-scale constructional programmes, Dexion angle is competitive with other materials, more especially where dismantling and rebuilding are likely to recur.

Spaced closely throughout the length of the material, the slots obviate drilling and, in the absence of portable equipment, associated handling between shops and site. The material does not deteriorate and dismantled parts may be re-used. Particularly suitable for stores, racks, steps, tables, or benches, it serves also for the framework of sheds and garages. For shelving and table tops, Dexion panels 36 in. × 6 in × 1 in are supplied in aluminium alloy and steel, weighing approximately 1¾ lb and 4¾ lb respectively. Cutters, castors, hinges, nuts and bolts are also supplied by the manufacturers, Dexion, Ltd., 189 Regent Street, London, W.1. (1987)

Castrol Additives

CASTROL oils have for some time embodied additives to provide detergent, anti-oxident and anti-corrosion properties. These additives which were formerly obtained from dollar sources, are now being produced on a large scale by the new Castrol plant at Stanlow, Cheshire. (1985)

NOISE REDUCTION

Part II: Measures Applicable During the Development Stage

IF a programme of noise research and development of any magnitude is to be undertaken it is useful to have a specially constructed quiet-room with an electricity supply laid on for the instruments. It should be well lagged with an absorbent material to prevent reverberation. "Stillite" is a suitable material for this purpose, as it has good sound-absorbing properties and can be obtained in slabs 2 in thick which are easily applied. Stationary sound waves should be obviated as far as possible by arranging that there are no parallel walls to the room.

If stationary waves are in existence the air in the room vibrates in such a manner that nodes and anti-nodes occur in fixed positions in the room; a node being a point of zero amplitude of vibration and an anti-node a point of maximum amplitude. Consequently, a microphone placed at an anti-node might record a high intensity of sound yet, if it be moved a few inches to a node, it could record almost zero intensity of sound. This effect can be perceived by ear. When stationary waves are present, the air in the room is in a state of resonance which can give a false impression of the power of a source of noise. It should be remembered, when making records or when reproducing noises with a loud speaker, that the acoustical deadness of a lagged room will have a marked effect on the results.

Instruments and their uses

As far as the choice of instruments is concerned, great care is necessary. It is essential in most cases that they should have a flat response over the entire frequency range to be investigated, and that they may be calibrated easily.

There are numerous instruments for measuring noise level, and most of these can be used in a car on the road. For instance, the Standard Telephone and Cable Co. make a meter that is used in conjunction with a microphone and an amplifier, and with or without their octave filter. When used without the octave filter, total noise is registered on the meter, but with the filter in circuit it registers only a small range of frequencies at each setting of the filter control. Filters which reject all but one particular frequency at a time are available, but these are much too selective for general use.

The frequency spectrum Fig 3, Part I, was obtained with an octave filter. This type of diagram is useful as it shows exactly which frequencies are the more troublesome. Making use of this knowledge, it is possible to select the most suitable materials and methods to suppress the offending frequencies. A noise is identified by its frequency, and it follows that if a particular frequency is found to be causing trouble its origin may be traced by searching for the particular panel or part of the vehicle which is vibrating at that frequency. Identification of the frequency of a troublesome noise may be made in the first place by a study of the frequency spectrum. It can then be checked aurally by comparing a recording of the noise with the output of a loud speaker, the frequency of which is controlled by an oscillator.

Fig. 10. Type 74100-A spectrometer by Standard Telephone and Cables Ltd.

The search for the offending panels can be made with a probe-type vibration pick-up such as those made by Cosmocord, Ltd., of Enfield, the Rothermel Corporation, Ltd., of London, N.W.6., or the General Radio Co. (U.S.A.). The probe is placed on the panel under investigation and used in conjunction with an amplifier and meter to indicate the characteristics of the vibration being measured. A certain amount of skill must be exercised when using a probe type of pick-up. Insufficient pressure allows the probe to jump off the surface of the panel, and it then fails to record the vibration accurately. On the other hand, should the probe be applied too firmly, it may cause a node to form at the point of application, and thereby completely change the mode of vibration.

Another use for the probe type of vibration pick-up is to make a plot on a panel of the mode of the vibration, such as that for a door panel illustrated in Fig 8, Part I. The probe is used to search local areas of the panel for points of maximum amplitude. These are recorded by chalk-marks which form a pattern of anti-nodes. Similarly, points can be marked where the amplitude is not quite so great as the maximum, and a line can be drawn joining all points where equal amplitudes of vibration occur. These patterns are very useful to determine the best position for stiffening brackets, and where to apply damping materials, such as Bittac, to obtain the best and most economical results.

A medical stethoscope is a very useful instrument to use in a search for a noisy panel as the noise of any particular panel can be isolated by this instrument, and can be identified aurally by its pitch. Unfortunately it is not easy to use the probe or stethoscope when on the road.

Another method of detecting resonant frequencies has been used with some success. This is the use of a loudspeaker element as a vibrator, with the cone replaced by a rod that is allowed to bear on the panel whose natural frequency is to be determined.

The frequency output of the speaker element is varied by means of an oscillator. It is then possible to see and hear resonance in the panel, and a note can be made of the resonant frequencies.

The best method of evaluating the effectiveness of any modification aimed to reduce the noise level in a car is to make noise records under the appropriate conditions, before and after modification. For this purpose a disc recorder is convenient, as each recording can be made on a separate disc and then played back on twin turntables. A two-way switch can be used to change instantaneously from one to the other and thus permit a direct comparison.

Similar effects may be obtained with two tape recorders, or with one alone in which the two recordings follow one another on the tape. When the two are on one tape, it is not possible to switch at will from one to the other or from one particular part of a recording, giving some transient effect, to the other. In the case of the disc recorder, variations of the depth of cut in a groove on a circular disc record the variations of sound. On the other hand, the recording on tape is made by inducing varying degrees of magnetization along its length. The tape can be demagnetized and re-used repeatedly. By comparison, therefore, the disc recordings are more expensive. The tape recorder is usually more compact than the disc type, and is less susceptible to damage in a car performing violent manoeuvres or travelling over rough ground. As far as quality is concerned, the result is very dependant on the properties of the tape, and in this respect the products of different manufacturers vary substantially. When all factors are considered, the advantages of the disc type of unit may well outweigh its disadvantages.

There is, however, one serious problem to be overcome before recordings of noise in motor vehicles can be regarded as satisfactory. Apparatus at present available for the recording and reproduction of noise, although satisfactory as far as speech or music is concerned, can give misleading results at the low audio-frequencies that are most troublesome in motor vehicles. The frequency response of such apparatus is likely to be irregular and the reproduction could, by giving undue weight to one series of frequencies, mask another series in which the investigator may be particularly interested. It is possible, of course, to substitute a pen recorder for the sound recording instrument, or to photograph the trace on an oscilloscope.

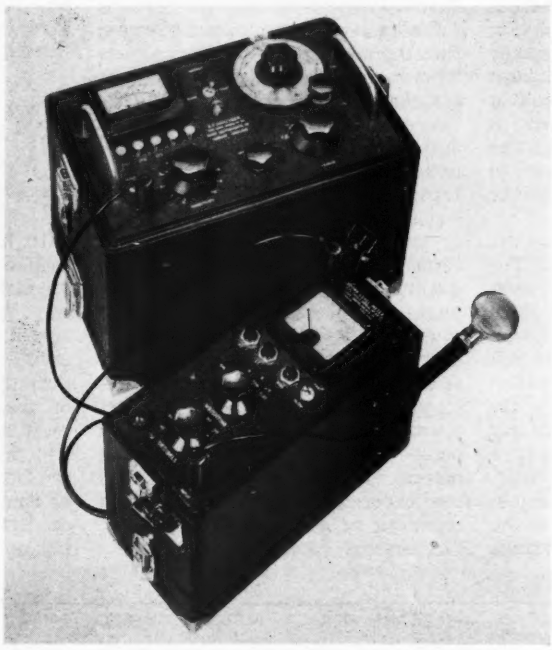


Fig. 11. Sound level meter and audio-frequency analyser by Dawe Instruments Ltd., Hanwell

Such recordings are usually much too complex to be of general use, but the trace can be analysed on the lines indicated in *Wave Form Analysis* by Manley.

When the frequency-response problem has been overcome, the recording and then the direct comparison of the recorded noises will be the only satisfactory method to employ. If two vehicles are taken on the road to be compared by ear, it will be found that by the time the investigator has changed from one car to the other, and attained in the second car the appropriate road speed, he will have lost his impression of the exact noise level in the first one. It has been determined by experiment that after a noise has ceased for a matter of a few seconds only, an observer cannot, with any satisfactory degree of accuracy, judge if a second noise is of the same noise level as the first one.

Rotating drums

A useful piece of apparatus for noise investigation is a pair of drums on a common axle mounted horizontally in a pit so that the top points of the drum peripheries are level with the floor, or slightly below it. The width of the drums and their spacing should be such that a vehicle of any normal track can be placed with either its front or its rear wheels resting on the drums. Any form simulating road surface, or for that matter any other shape, can be cast in aluminium as semi-circular segments which can be bolted to the circumference of the drums. A steel cover over the pit will permit a car to be driven until its front or rear wheels drop on to the top of the drums through apertures in the cover. The other pair of wheels of the car is held by chocks suitably anchored to the floor.

Unfortunately, it is impossible to eliminate altogether the noise of the rotating drums and their driving motor, but the pit should be well lagged with absorbent material and sound-proofed as far as possible. It is essential that the circumference of the drums should be true, as any eccentricity will give rise to a harmonic excitation of the vehicle and may tend to obscure any other vibrational effects. Furthermore, the drums should be well balanced.

The starting torque necessary will be high if the drums are not made with as low a mass moment of inertia as possible since they should be 5 ft or more in diameter to avoid undue experimental errors which might occur as a result of the curvature of the surface. On the other hand, the construction must be rigid and adequate to sustain the centrifugal force set up in operation. It should be borne in mind that this same apparatus may be useful for carrying out fatigue tests with fairly large bump lobes fitted on the drums, and that it should, therefore, be made both dimensionally suited and strong enough for this work. Cast segments must be tightly secured to the circumference to prevent rattling, and should be designed for speedy attachment and removal, otherwise much time can be wasted on these operations. An indicator calibrated in drum r.p.m. and also in drum circumferential linear velocity in m.p.h. should be fitted. The frequency of a forced vibration can be calculated from the r.p.m., and work done on the road at given speeds can be correlated with that done on the drums by observation of the circumferential linear velocity.

A forced vibration can be applied to the wheels and its frequency can be varied by adjusting the speed of the

driving motor if the drums are used with a specific number of regularly spaced bumps on their peripheries. For instance, the bumps may be furnished by cast aluminium segments having a shallow saw tooth surface, each tooth being about 3 in long and $\frac{1}{8}$ in high. It will be noticed, when sitting in the car, that as the speed of the drums increases, pronounced resonances can be heard. At some speeds these will be louder than at others. The loudest resonance is usually at the frequency at which the largest number of panels resonate at the same time, and occurs at the frequency of road roar.

It is possible to isolate some of the noises experienced on the road. For instance, rolling and suspension noises may be recorded on a suitable down hill stretch if the half-shafts are removed and the car allowed to run with the engine off. A good method to check wind noise is to choose a day when there is a steady wind of say 40 m.p.h. blowing directly along a straight and smooth stretch of road. Run the car into the wind at 40 m.p.h. and then away from the wind at the same speed, and compare the results by a meter analysis, or by recordings, or by both methods. This gives wind velocities relative to the car of 80 m.p.h. and zero m.p.h. on consecutive runs. Axle whine can probably be best investigated on a test rig incorporating loading devices to simulate road conditions. Engine noises, of course, can be eliminated on the road by running downhill with the engine out of gear and switched off.

Road roar

If a particularly troublesome road roar is apparent in the car, the following procedure should be adopted. Its frequency should be determined with the aid of an octave filter, or by a wave form analysis of a pen recording, and checked by comparing a recording of the road roar, by ear, with the output of an oscillator coupled to a loudspeaker. This frequency will probably coincide with one of the resonant frequencies obtained on the drums. The next step is to use a vibration pick-up to determine exactly which panels are vibrating at the road-roar frequency, and to plot the modes of vibration in the manner already described. Having this information it is then possible to apply suitable corrective measures, as outlined in Part I.

There is some evidence to suggest that the air inside a saloon car body vibrates in resonance at a road-roar frequency in the manner of a tube closed at both ends, see Fig 12. Some authorities go as far as to state that it is this natural vibration of the air that constitutes road-roar, and not the resonant vibration of panels. A singing or musical note can be heard under certain road conditions, and the quality of this note is such that it might be expected to originate from a source of that nature. If a microphone is traversed from end to end of the saloon, the noise amplitude increases towards the centre and diminishes towards the extreme ends, as would occur with an air vibration of this nature. The frequency of the road roar experienced in a certain car was found to be about 115 c/s, and the fundamental natural frequency of a closed tube is given by the equation :

$$f=\frac{c}{2L}$$

where c=the velocity of sound in air
=1,100 ft/sec approx.
f=fundamental frequency, c/s
L=length of the tube, ft

By substituting the length of the interior of the saloon for L it was found that a result of 115 c/s was obtained for the natural frequency. Higher harmonics can be calculated from Rayleigh's formula :

$$f=\frac{c}{2}\left(\frac{A^2}{L^2}+\frac{B^2}{W^2}+\frac{D^2}{H^2}\right)^{\frac{1}{2}}$$

where L=length, ft
W=width, ft
H=height, ft.

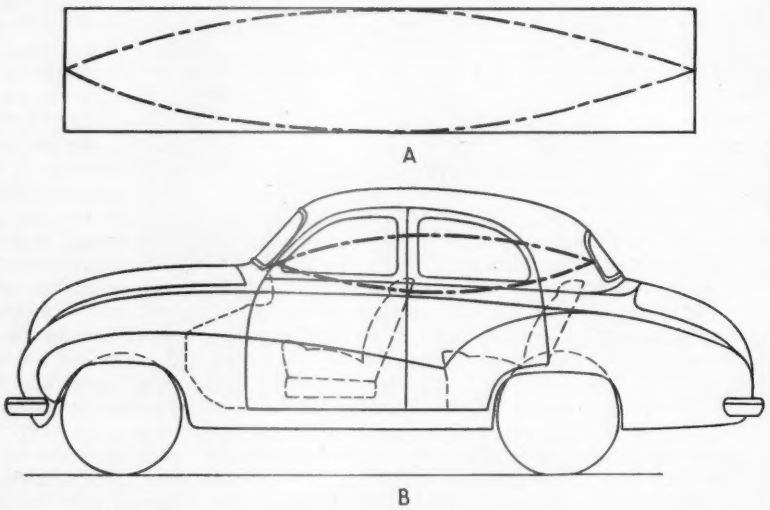
and A, B and D are integers substituted in turn in the formula. The three lowest frequencies are :

$$f_1=\frac{c}{2L}$$

$$f_2=\frac{c}{2W}$$

$$f_3=\frac{c}{2H}$$

It has been suggested that the excitation of the road roar may be due originally to the compression of air, and then its sudden release with almost explosive force from the small cavities in the surface of a freshly made road. This hypothesis is based on the observation that road roar is most prevalent on that type of road. The theory is further strengthened by the fact that road roar is equally loud, or even louder than normal, when the car is run on smooth tyres, that is to say, on tyres from which the tread has been machined for the purpose of the experiment. The reason for the explosive release of compressed air in the tiny pockets is somewhat obscure, but it could be that its temperature is raised considerably both by the mechanical work done on it during compression, and by conduction from the surfaces of the road and the tyre at the area of contact where extremely high local temperatures may possibly be developed by friction. It might be worth while to do some research on this subject, if only from the point of view of tyre wear.



A Mode of vibration in a closed tube
B Similar mode in a saloon car

Fig. 12. Resonant air vibration

Testing acoustic materials

One of the tests which must be done by development and research staffs is the testing of materials to determine their relative value as far as application to motor cars is concerned. This should be done, if possible, in the quiet room. Tests

of materials when actually installed in a car, although desirable, are very time consuming and expensive. One of the more difficult properties to determine is the absorption coefficient of the material. The method used at the National Physical Laboratory requires very large and costly apparatus, and the size of specimen to be tested is roughly 10 ft square. Their method is undoubtedly the best and they will undertake to carry out tests for industry.

A somewhat less satisfactory method is that of Wente described under the heading of "Standing Wave Methods of Testing Absorption Coefficients" in *Applied Acoustics* by Olsen and Massa. It is, however, a more suitable method of test for use in an establishment with limited resources to devote to this aspect of research.

Briefly, the method is to vary the effective length of a steel tube, 9 ft long, 3 in inside diameter and $\frac{1}{4}$ in thick, by means of a piston on which is mounted the material to be tested. The other end of the tube is fitted with a heavy diaphragm attached to a voice coil that is driven from a conventional dynamic speaker field. The maximum and minimum pressures, P_{max} and P_{min}, are measured near the source of sound as the tube length is varied. The coefficient of absorption is given by:

$$a = \frac{4\sqrt{P_{max}\,P_{min}}}{P_{max}+2\sqrt{P_{max}\,P_{min}}+P_{min}}$$

The disadvantage of this method is that the noise only strikes the sample at normal incidence, whereas in practical use of the material the sound strikes at random angles and, in addition, the material is used in much larger sheets. Both these factors affect the accuracy of the results. However, for comparing one material with another, as distinct from obtaining an absolute absorption coefficient, this method is satisfactory. With a tube of these dimensions measurements can be taken with frequencies down to 60 c/s.

It is not possible to obtain very accurate measurements of insulation or absorption characteristics with small samples of material. The reason may be illustrated by a comparison between the diffraction of sound and light; both wave motions. An obstacle interrupting light throws a very distinct shadow, but an obstacle in the path of sound waves does not obscure the sound in its wake with anything approaching the same effectiveness. The explanation is that most obstacles to the passage of sound are not large compared with the wave length of sound. The wave length of a fairly low frequency of sound might be, for instance, of the order of 5 ft, whereas the wave length of light would be minute by comparison.

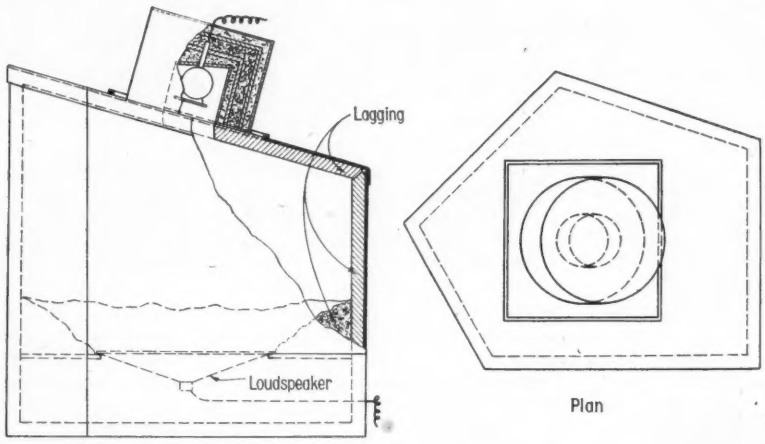


Fig. 13. Test apparatus for insulation materials

Bearing these facts in mind, an experiment in a large tank of water will demonstrate the effect of an obstruction on wave motion. If ripples are caused to travel over the surface and a small rod is placed vertically in their path, it will be seen that an inch or so behind the rod, the wave motion is not appreciably different from that in front of the rod. If, on the other hand, an object which is large by comparison with the length of the waves is placed in the tank, the area behind is completely screened from the wave motion.

It follows that at high frequencies a small sample of insulating material placed in the path of sound waves will appear to have better insulating qualities, as recorded by a microphone placed near the side of the material opposite to the source of sound, than at the low frequencies, which have a longer wave length. It should be made clear at this point that it is impossible to construct an absolutely sound-proof barrier round the edges of a thin sheet of material under test.

For the measurement of transmissibility or, alternatively, of insulation coefficients it is advisable to send a large sample of the material to the National Physical Laboratory, or a similarly equipped research establishment, for test. However, it is possible to compare the effectiveness of one material with that of another with a simple apparatus that can be made in the experimental department.

Shown in Fig 13, the apparatus consists of a 16 S.W.G. steel box, with none of its sides parallel, lagged with slabs of Stillite, or a similar material, to reduce resonance effects and standing waves. The lid must be an exceptionally tight fit as the volume of sound escaping through small cracks is out of all proportion to the size of the cracks. In the box is a loudspeaker unit mounted face upwards on a baffle. At the top of the box and opposite the speaker, an aperture, about 1 ft square, is cut in the lid. Around this a soft rubber sealing strips forms a seating for a square sample, tested either on its own or mounted on a 20 S.W.G. steel sheet to estimate its effect in conjunction with the steel. Under the centre of the square, a circular hole is cut in the lagging concentric with the circular aperture of an insulated bell-shaped container of 16 S.W.G. steel. The bell contains a microphone and is placed on top of the sample. Lagged, and shaped so as to avoid standing waves, the interior of the bell is just big enough to house the microphone. Layers of different materials are probably best for lagging purposes: Stillite wool, acoustic felts, rubber sheet, Insulgrey and bitumen impregnated sheets would appear to be suitable. The outside of all the apparatus is treated with Bittac to reduce the possibility of resonant vibration of the steel sheet of which it is made.

It is advisable to fit a bracket to support the microphone housing-bell, and to prevent it from moving under vibratory influence. This should be marked so that the bell can always be placed in exactly the same position. Another refinement which might be incorporated is a device to ensure that the height of the microphone relative to the speaker can be adjusted so that it is the same with, or without, a sample fitted.

The principle of operation of the test apparatus is to generate in the box, by means of an oscillator and a speaker, a sound of known frequency. Only a small proportion of the sound will escape through the sides of the box. That which does is further prevented from getting to the microphone, when arranged as shown in the diagram, by its surrounding insulated bell. Sound does reach the microphone, however, through the aperture, and the volume of the sound is adjusted until that recorded by the meter, used in conjunction with the microphone, is 100 decibels. The sample to be treated is then interposed between the microphone and the speaker by placing it over the square aperture in the lid of the box, and another reading is taken of the sound level received by the microphone in the bell placed on top of the sample. The difference between the first reading of 100 decibels and the second reading is a measure of the efficiency of the sample as an insulator. This measure can, as mentioned before, only be used for comparison with results obtained for other materials. It should be remembered that the test panels themselves may have pronounced resonant frequencies. These usually show up as a peak on the curve of the results and may, therefore, be easily recognised.

Several precautions should be taken when using this apparatus. Ascertain that the lid of the box is fitted properly and that the sample is well seated over the aperture. The mouth of the bell resting on the sample should be faced with a soft insulating material to allow it to bed down properly, and to reduce the possibility of vibration being transmitted from the box to the bell and thence to the microphone. The bell and microphone should always be placed in the same position relative to the box and speaker. Turn the sample successively through 90 deg and take four readings at each frequency. Check for discrepancies and then take the average of the four readings.

As far as testing felts, etc. with this apparatus is concerned, their small mass and lack of elasticity would seem to indicate that they are poor insulators, and that most of the noise reduction obtained in its passage through the material is due to viscous friction in the pores or interstices. From this it can be assumed that the results obtained with this apparatus are a very rough indication of the absorption characteristics of this type of material.

In the other class of materials to be tested are those used for damping. An apparatus for testing these can be made as follows: a sheet of 20 S.W.G. steel is checked for gauge, and cut square to suitable dimensions giving a natural fundamental frequency of 100 c/s when simply supported, with edges not clamped. It is mounted with its edges in very shallow grooves in a solid wooden frame that is fitted, in turn, in a vertical position on a timber base. A loudspeaker is placed close to one side of the plate and a condenser plate is positioned close to the other side, at an anti-node. The square plate itself forms the other plate of the condenser. When the square vibrates the condenser gap will vary and so, therefore, will its capacity. This variation can be measured by suitable electronic equipment, or it can be shown on a cathode ray oscilloscope and photographed if necessary. Higher resonant frequencies than the fundamentals may be excited and the amplitudes measured, provided alternative mountings are arranged for the condenser plate to position it at an anti-node. The exact positions of the anti-nodes can be determined by vibrating the plate in a horizontal position and sprinkling sand on it. By comparing the amplitudes of vibration of the plate with and without damping materials applied. It is possible to obtain a measure of their relative effectiveness, and to determine the best thickness of application. The effect of age and drying of the materials should be given careful consideration.

Planned acoustical development work

If the acoustical properties of a newly designed car are to be really good, a definite plan of action must be followed. In the design stage careful attention must be given to every detail as it is put on the drawing board. The best result possible will not be achieved by any individual measure, but will be the cumulative effect of possibly hundreds of carefully thought-out details and arrangements incorporated in the design.

The function of the development department, as far as noise reduction is concerned, will be to make a final check on the work of the design department, only to ensure that they have forgotten nothing, for a well-designed car is not expected to be noisy. The check should be a properly planned one. Furthermore, adequate time must be allowed in which to do it thoroughly and methodically. Too often it is thought that a couple of days will be enough for this work. It is advisable for a prototype vehicle to be allocated solely for these tests, which should be allowed to progress without interruption until finished.

If the vehicle is supplied without trimmings or damping materials, ready access may be gained to investigate vibrating panels. A recording is then made on the road with the vehicle in the untrimmed state. This is most important, as it provides a basis for comparison to determine the value of measures subsequently taken to reduce noise. A frequency spectrum should be drawn up at this stage, and any particularly troublesome frequencies identified. Then the damping and trimming materials specified by the design department can be incorporated, stage-by-stage, and their effect noted. Finally, any further measures found necessary should be taken to secure the best possible results.

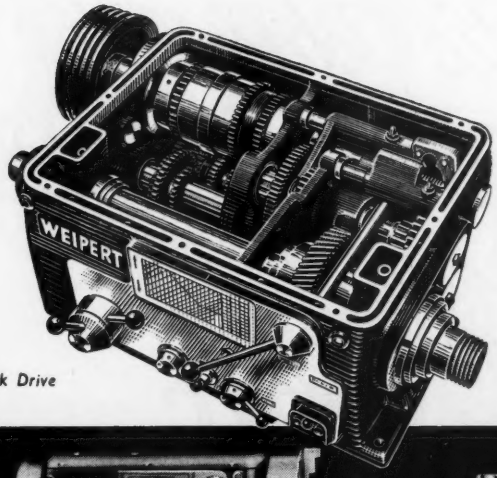
It is important that well qualified and experienced investigators be employed on this work and that, as far as is practicable, they be allowed to specialize. Co-ordination of the research and development work with that of the design department is essential. It is obvious that the specialists employed on the acoustical aspect of the problem should work in close co-operation with the designers to assist by keeping a close check on every detail.

Small-car Construction

ECONOMIC conditions in post-war Germany create the need for a new type of motor car which costs little, consumes little, and can be simply constructed with economy in raw material. Writing in *A.T.Z.* Vol. 52, No. 6, E. A. Cornelius makes the following suggestions:

(1) The conditions dictated by the need for economy are best met by a two-seater with adequate luggage space or a folding seat. (2) Only a closed car can give complete weather protection and be a real utility vehicle offering little air resistance. (3) Four wheels are preferable to three. (4) Road speed must be restricted. In the interests of engine life, touring speed should not exceed three-quarters of the maximum speed, and a figure of 40 m.p.h. is satisfactory. This would involve a power requirement of 10-12 h.p., of which only 5 h.p. would normally be used. Acceleration would be adequate at 1-2 ft per sec per sec. (5) A two-stroke engine, notwithstanding higher specific consumption, is preferable to a four-stroke on the grounds of cheapness and reliability. A twin-cylinder type is preferred. (6) An electric starter is indispensable. (7) Air cooling with a blower has advantages over water cooling. (8) Three forward gears are the minimum; it is doubtful whether a fourth gear justifies the expense. The reverse gear is indispensable. (9) For general utility, a two-wheel drive with differential is advisable.

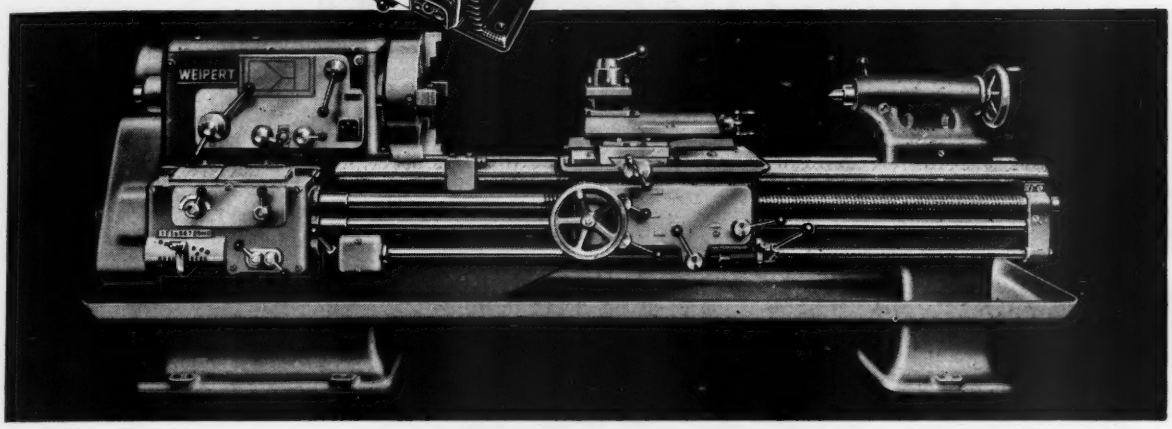
An experimental closed car with all-steel bodywork is described. (*M.I.R.A. Abstract No.* 5407.)



Headstock Drive

THE CENTRE LATHE THAT OPERATORS LIKE

for close tolerances and low cost production on small lots



TYPE WBE WEIPERT 19 5/8" SWING

HIGH-SPEED HEAVY DUTY LATHE

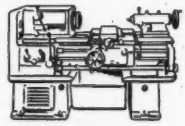
Centre lathe operators look for certain qualities in their machines. Rugged construction and high inherent accuracy, plus versatility and ease of operation, are the outstanding qualities. In the Weipert Heavy Duty Machine these features are well in evidence, inspiring operators to produce better, quicker and for less.

18 spindle speeds are available and 44 standard Whitworth and pipe threads from 2 to 30 t.p.i. can be cut without changing gears. 29 standard metric threads from .75 mm. to 15 mm. can also be produced. There's a coarse threading device for threads of 4 and 16 times their standard pitch, and a bridge for closing the gap in the bed, which is shown in position in the illustration above. Attachments for taper turning, copying and profiling, relieving, etc., are available if required.

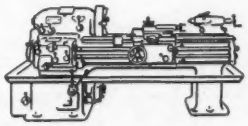
CAPACITIES

Max. swing over bed 19 11/16".	Swing over saddle .. 12 3/8".
Max. swing in gap .. 30 3/4".	Width of gap in front of faceplate 7 7/8".
Dia. universal faceplate 18 5/8".	

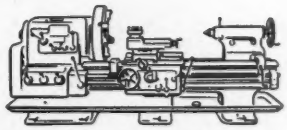
And it's available on reasonable delivery.



PRODUCTION LATHE PR.11.
Height of centres 8½". Distance between centres 1' 8" to 5' 0".



TOOLMAKER'S LATHE STR.21.
Height of centres 8½". Distance between centres 2' 5½" to 6' 6½".



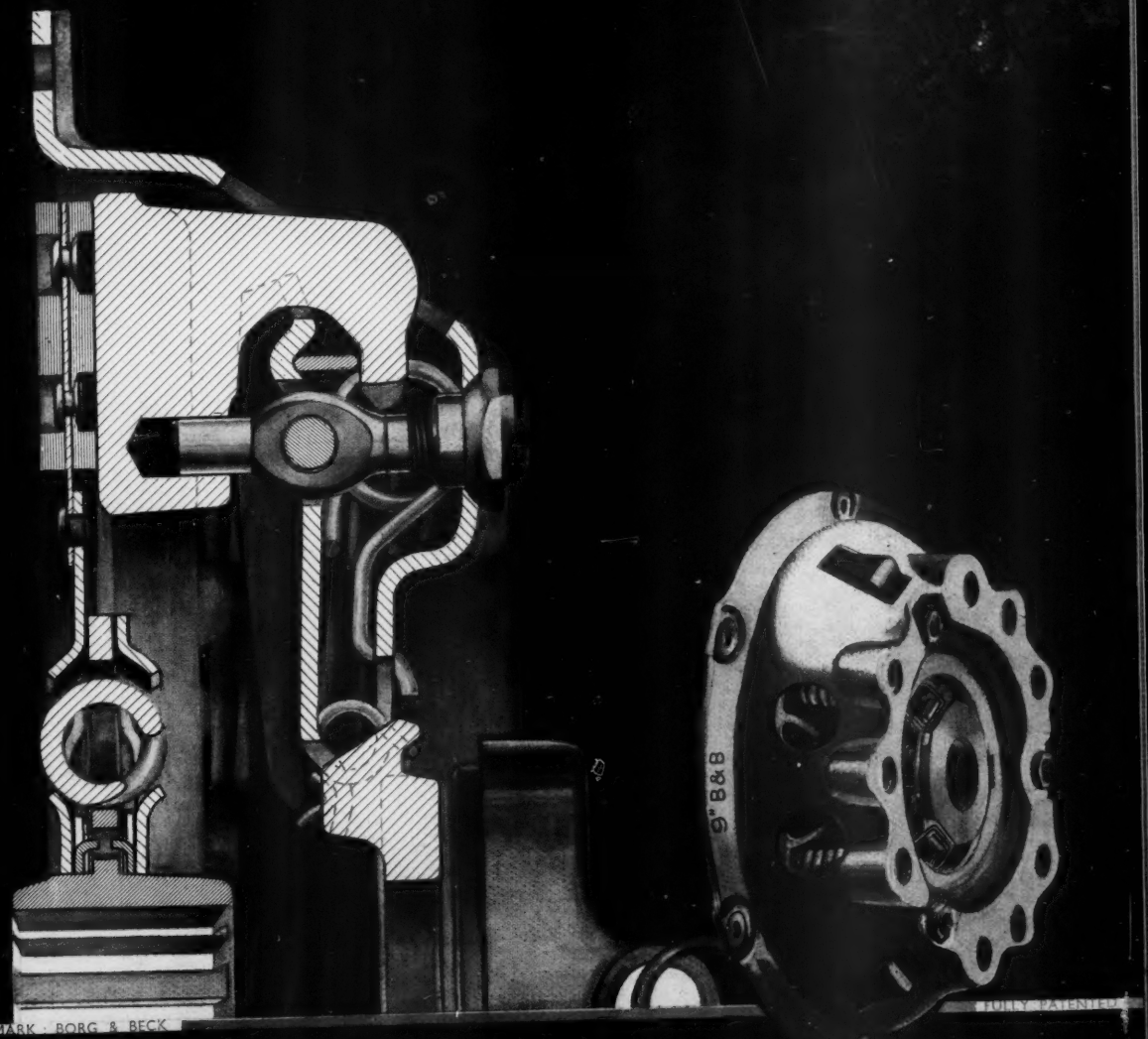
HEAVY-DUTY LATHE WEZ.
Height of centres 16". Distance between centres 3' 3½" to 19' 8½".

WICKMAN *of* COVENTRY

LONDON · BRISTOL · BIRMINGHAM · MANCHESTER
LEEDS · GLASGOW · NEWCASTLE · BELFAST

222 F79

CHOICE OF BRITAIN'S MOTOR INDUSTRY



BORG & BECK

INDUSTRIAL PROBLEMS THAT ARE SOLVED BY LOCKHEED

Many Lockheed hydraulic controls are used to actuate valves, dampers and other equipment which are remote and therefore not effectively actuated mechanically.

Other Lockheed controls are used to perform automatic cycles of operation; for example, Lockheed equipment is used for the actuation of highly specialized soot-blowing equipment, the use of which maintains boiler efficiency and thereby saves fuel.

Although the automobile engineer is chiefly familiar with Lockheed brakes and hydraulic servo systems, we feel that nevertheless he will find these applications of interest, even though they differ so greatly in scale and purpose.

AUTOMOTIVE PRODUCTS COMPANY LIMITED

LEAMINGTON SPA, ENGLAND

Regd. Trade Mark: LOCKHEED

You can spot the odd one out*

. . . but *never* in a run of Tru-Wel tubes. For that is what Tube Products' 20 years of experience has done. It has provided an ensurance of utter uniformity—a certainty that, from the first length in a run to the last, Tru-Wel tubes will not vary.

And that is also why, with Tru-Wel tubes, you can plan your assembly line boldly, in the sure knowledge that no "odd tube out" will interrupt the flow of production. Strength, lightness, concentricity, wall thickness and composition—all will be uniform.

Tru-Wel *Electrically Welded* Steel Tubes

Supplied in straight lengths from ½" o/d to 4⅜" o/d in gauges 22 to 6, or manipulated to your special requirements.

Tru-Wel *Stainless* Steel Tubes

Made from Austenitic steels of the 18% chromium 8% nickel type. In straight lengths ¼" o/d to 2" o/d in gauges 20 to 12, or manipulated to measure.

tested .. tried... trusted

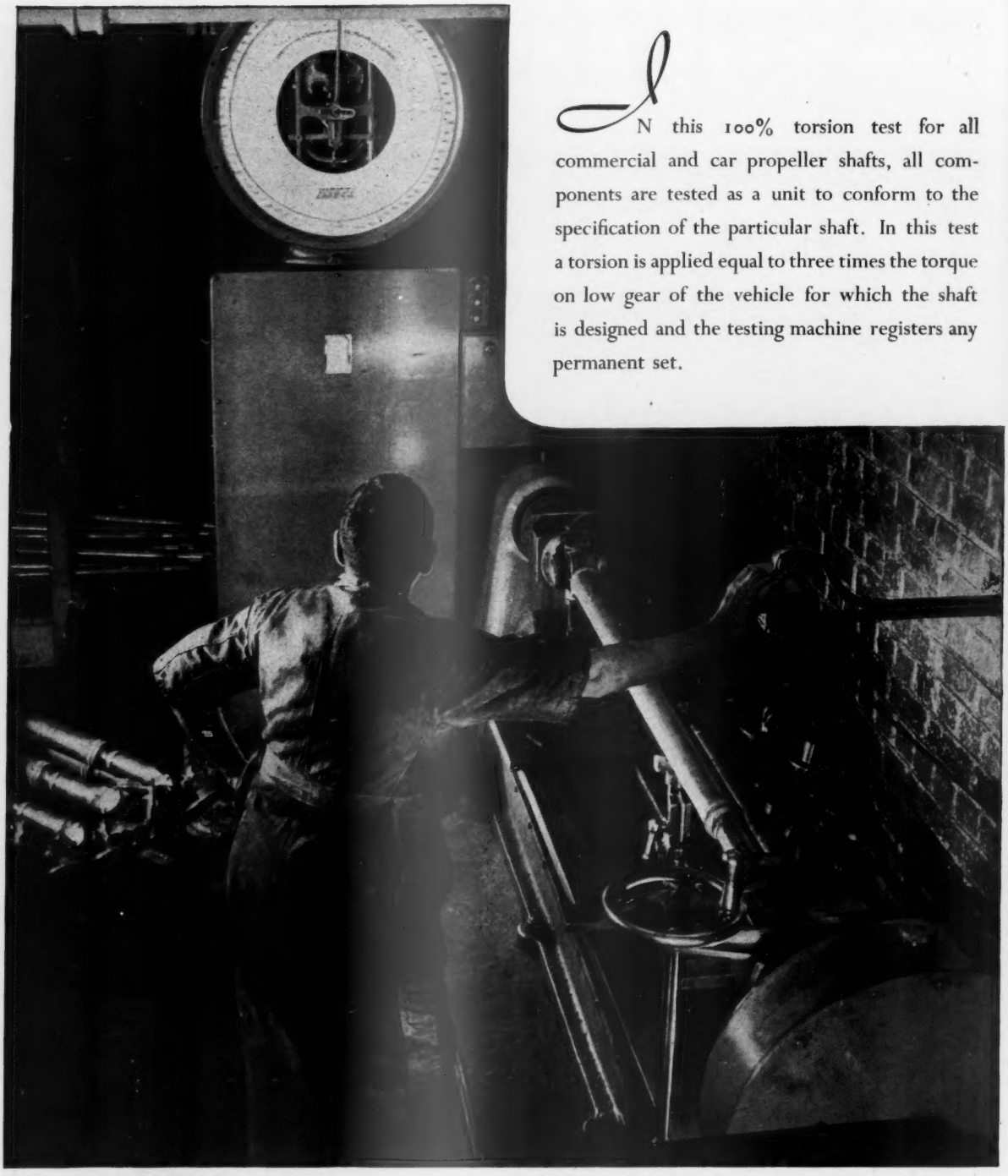
TRU-WEL

ELECTRICALLY WELDED STEEL TUBES

★ *Did you spot him? The 2nd policeman in the 2nd row has a different badge.*

A TI COMPANY

TUBE PRODUCTS LTD., OLDBURY, BIRMINGHAM



IN this 100% torsion test for all commercial and car propeller shafts, all components are tested as a unit to conform to the specification of the particular shaft. In this test a torsion is applied equal to three times the torque on low gear of the vehicle for which the shaft is designed and the testing machine registers any permanent set.

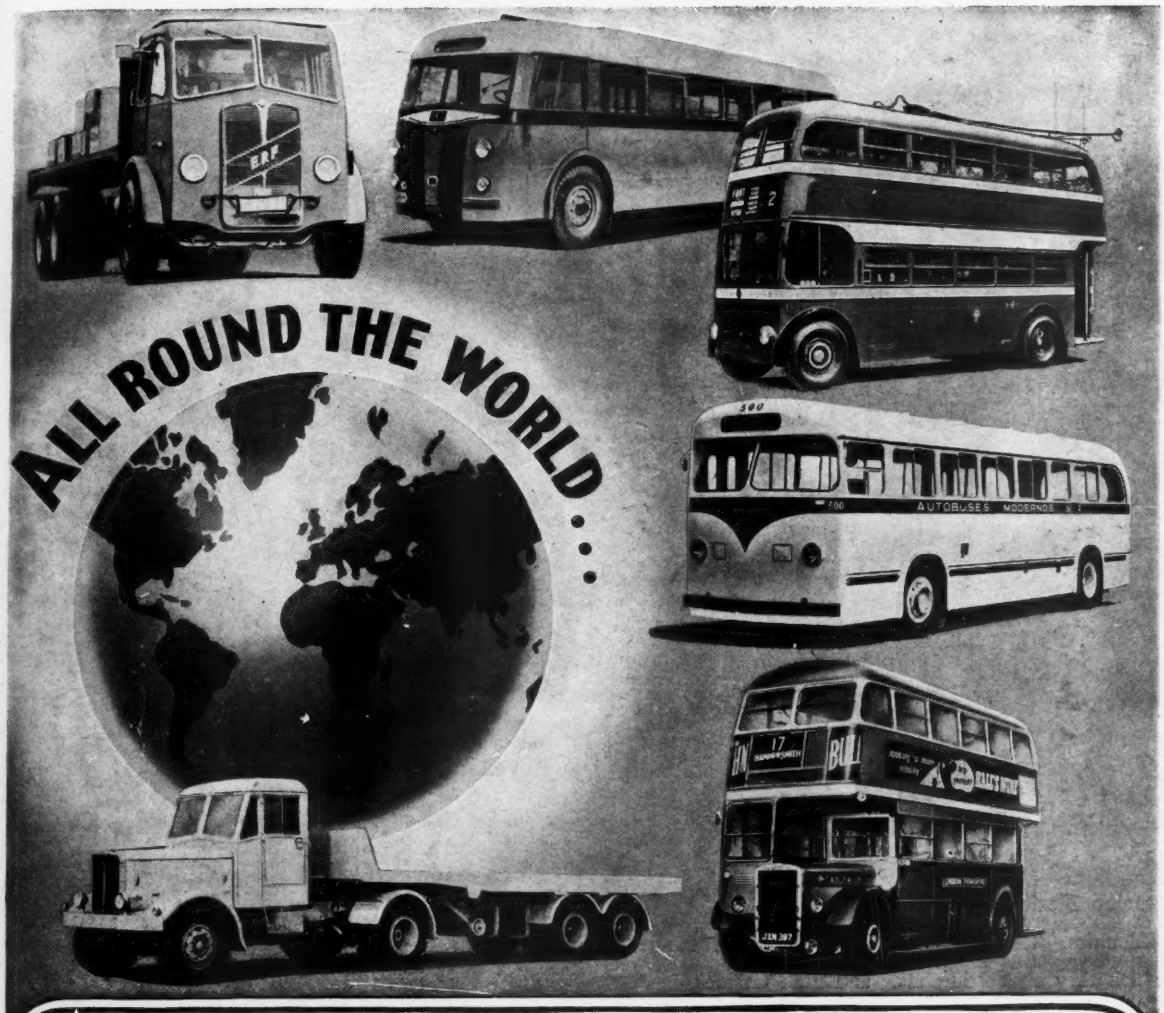
HARDY SPICER
NEEDLE BEARING

PROPELLER SHAFTS

Mass produced to high precision standards

HARDY SPICER & CO LTD (*A Birfield Company*) WITTON BIRMINGHAM 6

HARDY SPICER (AUSTRALIA) PTY. LTD., SOMERS STREET, BURWOOD E.13, VICTORIA, AUSTRALIA



SAFETY and EASY CONTROL are provided by

THE

WESTINGHOUSE

BRAKE

on many types of

HEAVY ROAD VEHICLES

THE design and manufacture of air brakes have been our business for over 80 years, and to-day they are the recognized standard of efficiency and reliability, as is evidenced by the thousands of Westinghouse braked passenger and goods vehicles in service in many parts of the world.

No matter what new chassis is being designed, there is a suitable Westinghouse brake available, comprising the latest design of compressors, reservoir units, control valves, brake cylinders and ancillary apparatus, to provide safety and easy control.

Full details from

WESTINGHOUSE BRAKE & SIGNAL COMPANY, LIMITED

82, YORK WAY, KING'S CROSS, LONDON, N.1

Sales Agents for Road Transport Undertakings: **EQUIPMENT & ENGINEERING CO., LTD., 2-3, Norfolk St., London, W.C.2**

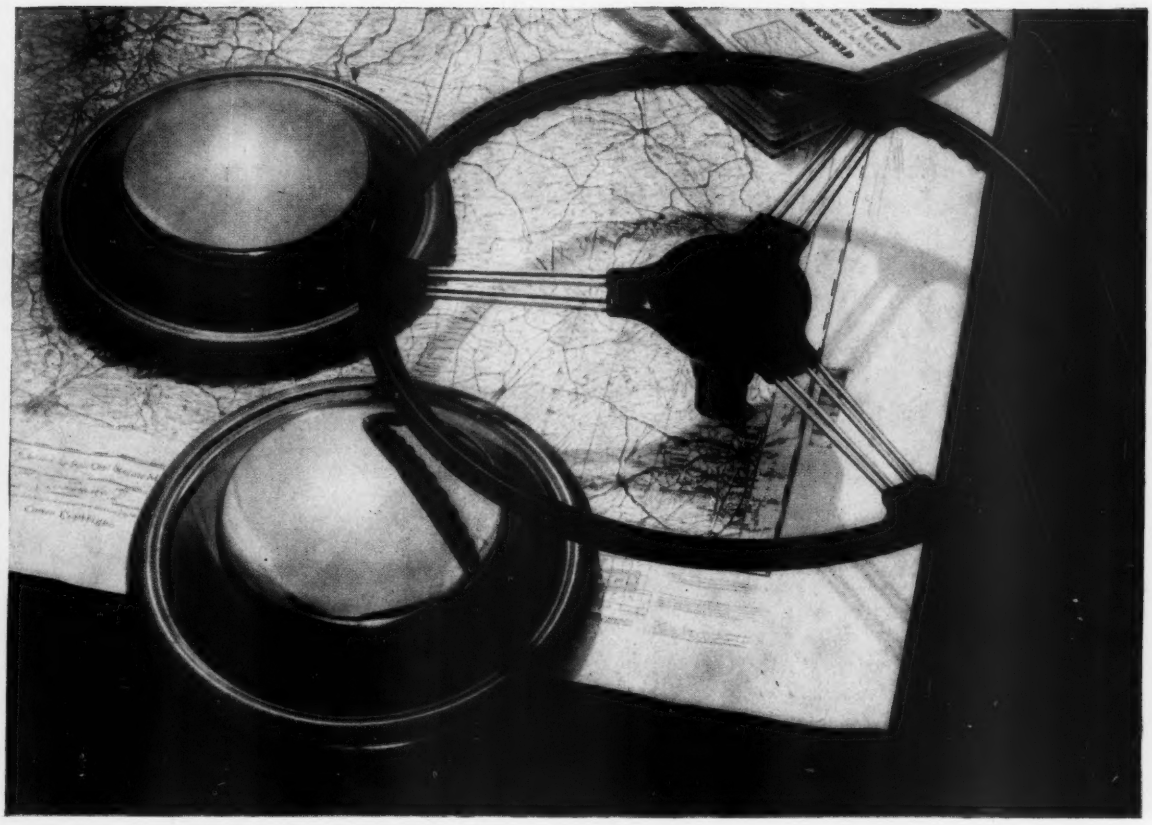
FBC

ALL-BRITISH
BALL & ROLLER BEARINGS

Ball and parallel-roller bearings for every purpose.

The illustration shows an F.B.C. sealed bearing on the rear axle shaft of a famous British car.

FISCHER BEARINGS CO. LTD., WOLVERHAMPTON
Manufacturers of S.B.C. and S.A.G. Bearings
Subsidiary of British Timken Ltd.
Works: Birmingham, and Duston Northampton.



"SILVER FOX" . . . *the metal of the age*

Registered Trade Marks

STAINLESS STEEL

Motor vehicle components and fittings made of Stainless Steel cause no anxiety to the owner—the surface can never wear or peel off; the metal is stainless right through. There is no need to polish; just a wipe with soapy water and they come up bright and unspotted for the whole life of the car.

When the nation's needs permit, "Silver Fox" will be available to the discriminating motorist in ever-increasing quantities.

Our colour photograph shows Hub caps by courtesy of the Ford Motor Company. Steering Wheel by courtesy of Wilmot Breeden Limited.

THE UNITED STEEL COMPANIES LTD

SAMUEL FOX & COMPANY LIMITED

Associated with The United Steel Companies Limited

STOCKSBRIDGE WORKS · Nr. SHEFFIELD · ENGLAND

F259

Radiator Production

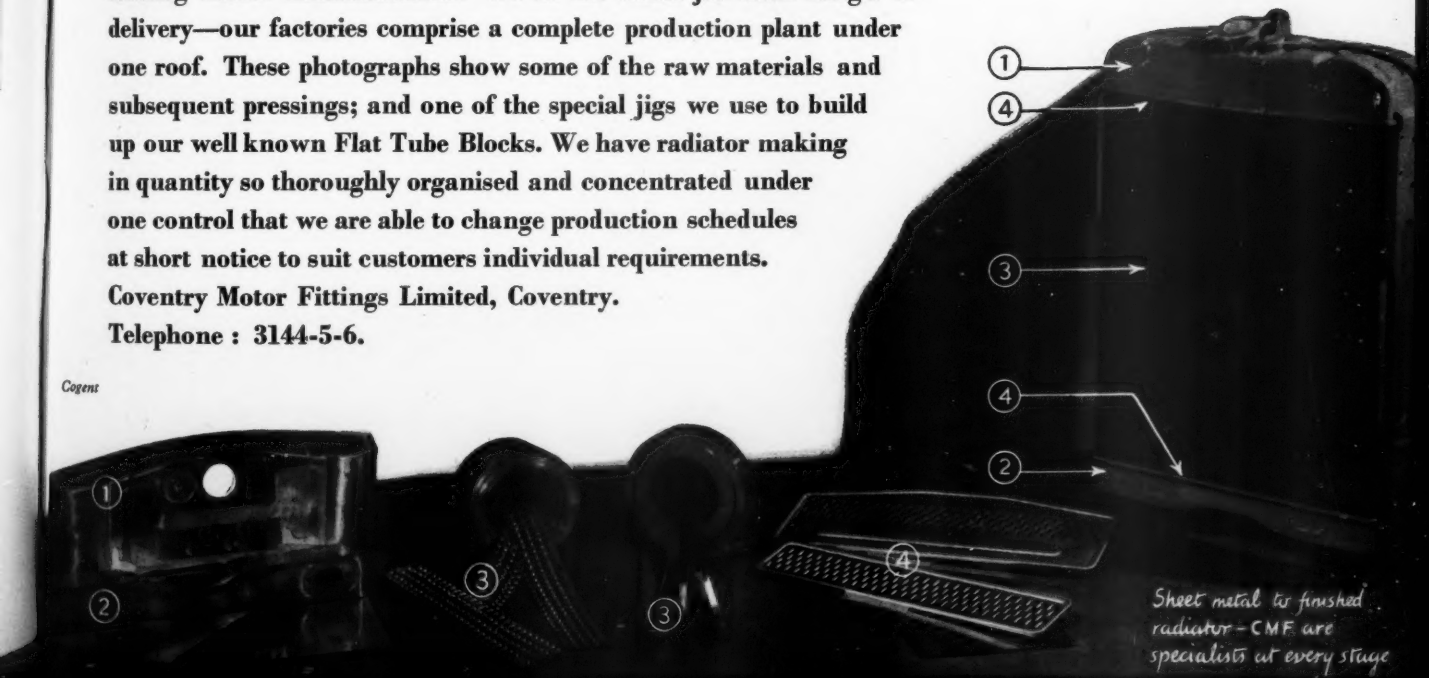
from A to Z

COVENTRY MOTOR FITTINGS

EST'D CMF 1902

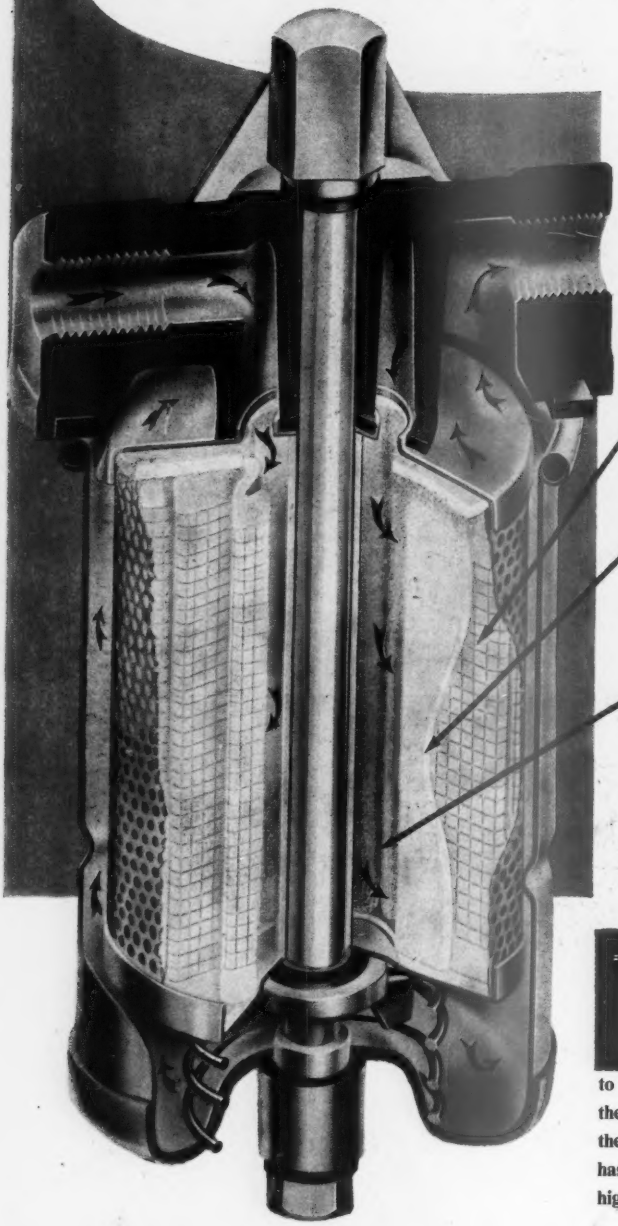
Here at C.M.F. in Coventry we make complete radiators for most of the leading motor manufacturers. We do the whole job from design to delivery—our factories comprise a complete production plant under one roof. These photographs show some of the raw materials and subsequent pressings; and one of the special jigs we use to build up our well known Flat Tube Blocks. We have radiator making in quantity so thoroughly organised and concentrated under one control that we are able to change production schedules at short notice to suit customers individual requirements.
Coventry Motor Fittings Limited, Coventry.
Telephone : 3144-5-6.

Cogent



Sheet metal to finished radiator - C.M.F. are specialists at every stage

ARE YOU GETTING
FILTRATION IN DEPTH?



Why has the basic principle of the VOKES filter element remained unchanged for over thirty years despite constant claims for cheaper and so called better methods? That is the vital question to be asked when considering filtration claims.

Here is shown the VOKES felt fabric element with its wire gauze outer retainer . . . not just filtration in only one plane . . . not just one surface through which particles can be driven.

Here is *filtration in depth* giving greater efficiency in arresting all particles large enough to span the oil flow . . . giving a build-up of sludge much slower than would be the case with an element filtering on its outer surface only.

Remember, also, the fact that in the VOKES type, filtration is from the inside to the outside which means that all the sludge is trapped in the *centre* of the filter element and cannot, in any circumstance, be allowed to recirculate.

You must filter all the oil all the time—even a full flow filter is not doing its job if the by-pass is brought into use for long periods when the oil is only ordinarily cold. The VOKES direct flow device exists purely as a protection to the engine and not to the filter. It only allows the oil to pass straight through to the engine if the filter has been so neglected that the element has been completely clogged up or if the oil is highly viscous through abnormal conditions.

★ ***VOKES FABRIC ELEMENTS ARE CLEANABLE!***

They give greater economy in the long run and ensure that plant and machinery is not put out of service through the non-availability of spare elements in remote places.

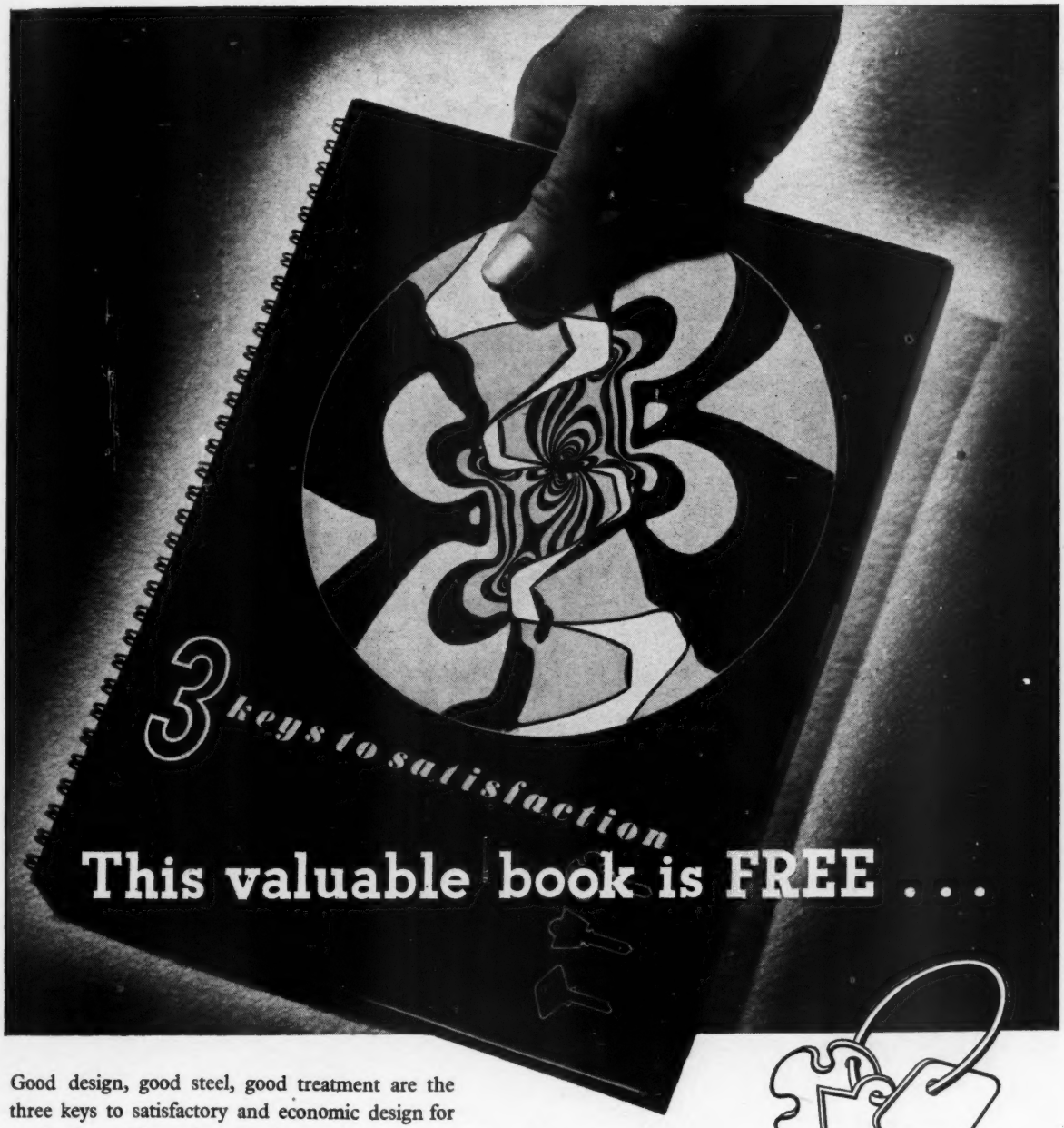
V63

VOKES

Pioneers of scientific filtration

VOKES LIMITED GUILDFORD SURREY

VOKES (CANADA) LTD. Toronto *Represented Throughout the World* VOKES AUSTRALIA PTY LTD. Sydney



Good design, good steel, good treatment are the three keys to satisfactory and economic design for production and service. If the design is poor, then the best steel and treatment will not redeem it, and vice versa.

Every engineer, designer, draughtsman, student will welcome this valuable summary in 72 pages of the facts relating to operating stresses, stress concentrations, what alloy steel to use for different applications, its treatment, etc.

Write now—a hundred valuable diagrams, graphs and tables.

Climax Molybdenum Company of Europe Ltd.

Technical Enquiries: **99 Pinstone St., Sheffield, 1**

(*Registered Office:* 2-3 Crosby Square, London E.C.3)

Please send your FREE Booklet
"3 KEYS TO SATISFACTION"
BLOCK LETTERS PLEASE

Name .....

Position .....

Company .....

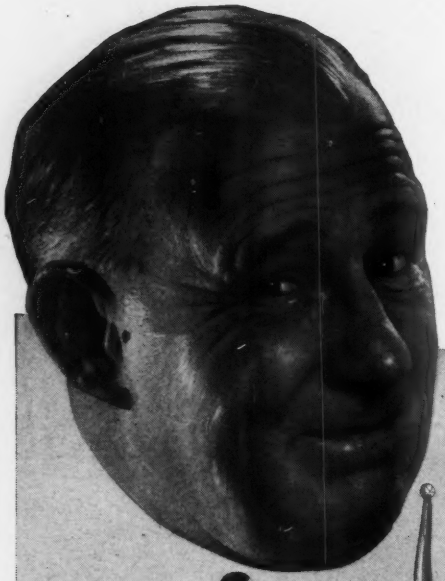
Address AE12

C 23

When I want a *CLIP* I turn to

TERRY'S

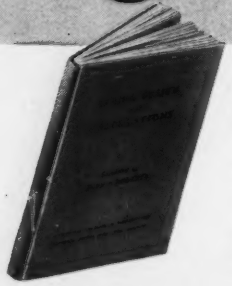
(the Spring people)



I go to TERRY'S for all kinds of CLIPS—steel, bronze, stainless, etc. When I want a clip made to specification, Terry's Research Department is a big help in the matter of design (Terry's with 96 years' experience should know a thing or two !)

and 3 Special Clips

Nos. 80 and 81 come from ½" to 2" from stock. No. 300, an exceptionally good drawing board clip, costs 5/- a doz. (inc. p.t.) from stock.



Want to know all about springs? Here is the most comprehensive text-book on springs in existence.

Post free 10/6

Sole Makers: **HERBERT TERRY & SONS, LTD., REDDITCH** • London • Birmingham • Manchester

HT4F

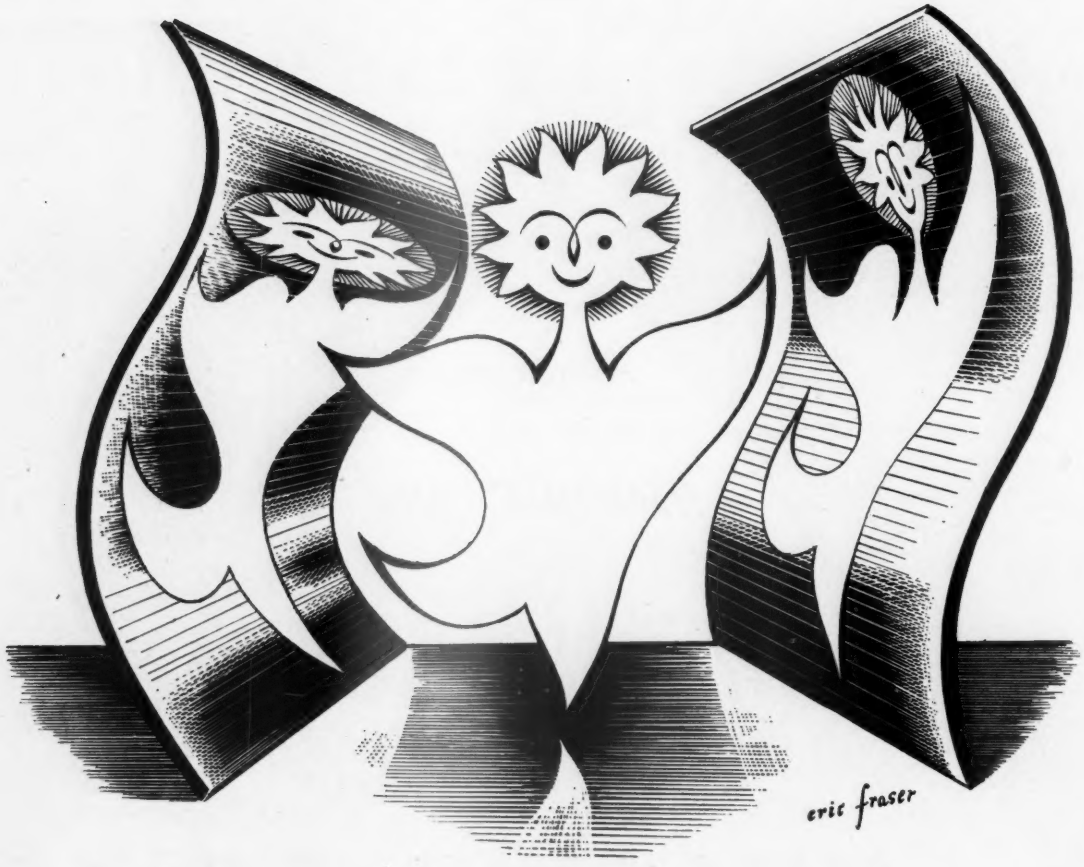
Nimonic 90 marks a further step forward in the development of materials for gas turbine construction. Its creep resisting properties are some 50° C better than those of Nimonic 80A, under all conditions. Even at 870° C it has a high load-carrying capacity for long periods.

"Nimonic" is a registered trade mark.

CREEP CHARACTERISTICS OF NIMONIC 90.

Time & Temperature		Stress (tons/in²) to produce creep extension of			
	°C	0.1%	0.2%	0.5%	Rupture
100 hour data	650	31.0	33.0	33.5	34.0
	700	24.0	26.0	27.0	27.5
	750	17.0	18.5	19.5	20.0
	815	10.0	11.0	12.0	12.5
300 hour data	650	29.0	30.5	31.0	31.5
	700	21.5	23.5	24.0	24.5
	750	14.5	16.0	17.0	17.5
	815	8.0	9.0	10.0	10.5
1,000 hour data	650	26.0	27.5	28.0	28.5
	700	19.0	20.5	21.0	21.5
	750	12.0	13.5	14.5	15.0
	815	6.0	7.0	7.5	8.0

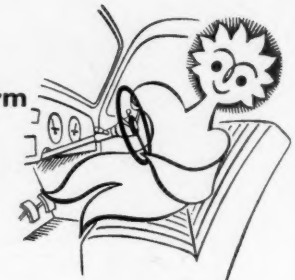
HENRY WIGGIN & COMPANY, LTD. HENRY WIGGIN **WIGGIN STREET, BIRMINGHAM, 16**



'FLEXIBLE' IS MY MIDDLE NAME! says Mr. Therm

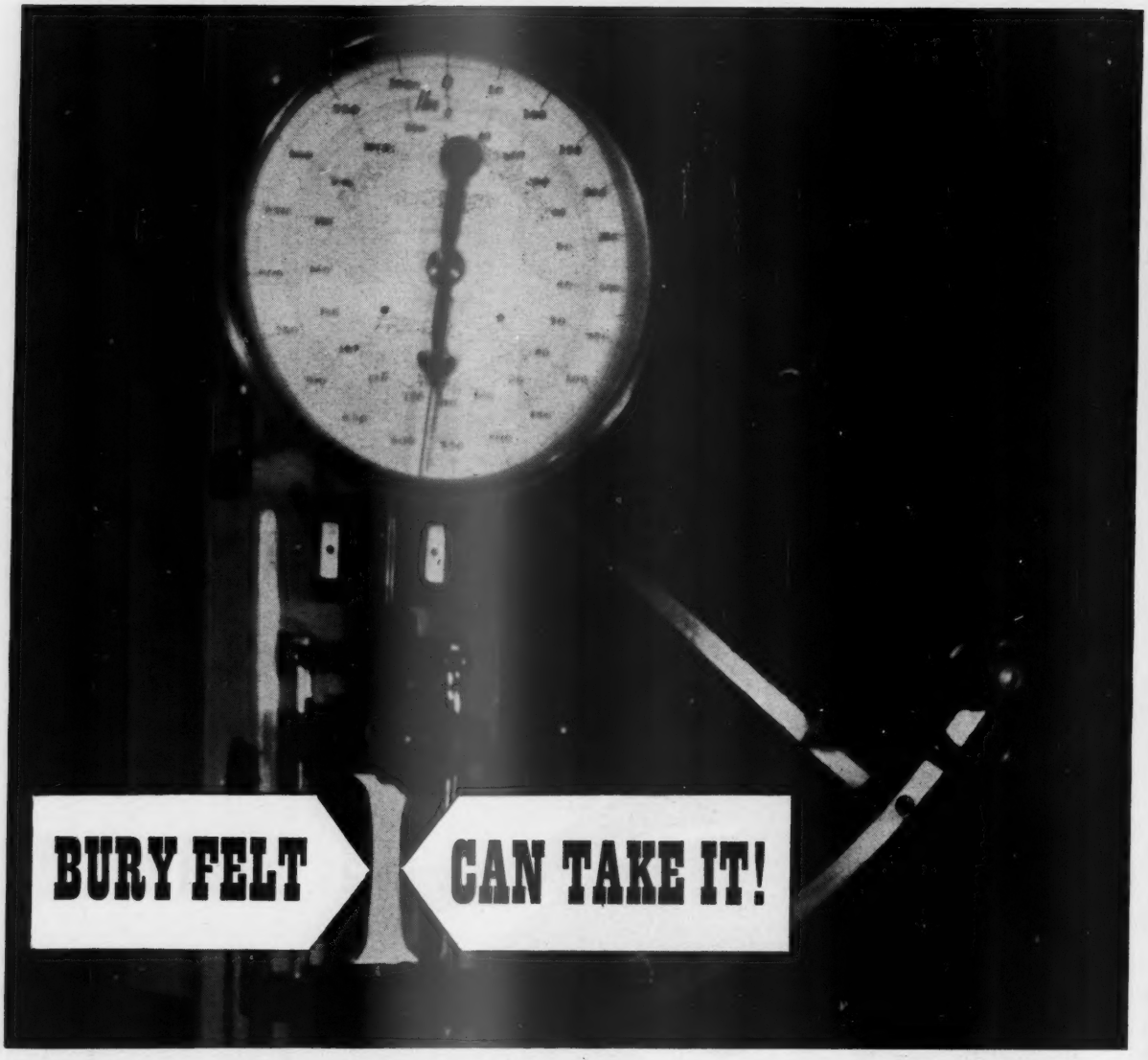
The gas and gas-heated equipment that Mr. Therm brings in his train are amazingly flexible in their applications to all sorts of heating problems. What other fuel but gas could give you a tiny—but steady—pin-point of flame or full heat the instant you want it? And gas can be controlled at the flick of a finger—or can be completely automatic if required. It needs no storage space, is smokeless and ash-free, and works unfailingly for you with remarkable efficiency. No wonder Mr. Therm is to be found hard at work in so many industries!

Mr. Therm takes a front seat



Yes, he's working hard for Briggs Motor Bodies Ltd., at Dagenham. These works concentrate mainly on Ford motor car bodies; and, working to capacity, they'll turn out 400 bodies a day—that means Mr. Therm's kept pretty busy! He lends a hand with annealing, tool hardening, rust proofing, paint drying and finishing, which involve the use of thermostatically controlled gas-heated ovens and furnaces. The 9,000 workers also have Mr. Therm to thank for their meals, which are cooked by gas.

MR. THERM BURNS TO SERVE YOU THE GAS COUNCIL · 1 GROSVENOR PLACE · LONDON · SW1



Another testing machine from the Bury Felt laboratory. This stretches the selected sample of felt, testing its behaviour under strain and its conformity with the predetermined breaking point.

Felt, like many other industrial products, must measure up to precise standards of behaviour under particular stress. The Bury Felt laboratory, with its special testing equipment, ensures that all Bury Industrial felts are ready to meet the particular needs for which they have been made.

In filters, seals, washers, buffing rollers, shock absorbing mountings and cushionings Bury Felts give a good account of themselves. These are just a few uses of the versatile materials which can be die-cut, chiselled, punched machined and even ground.

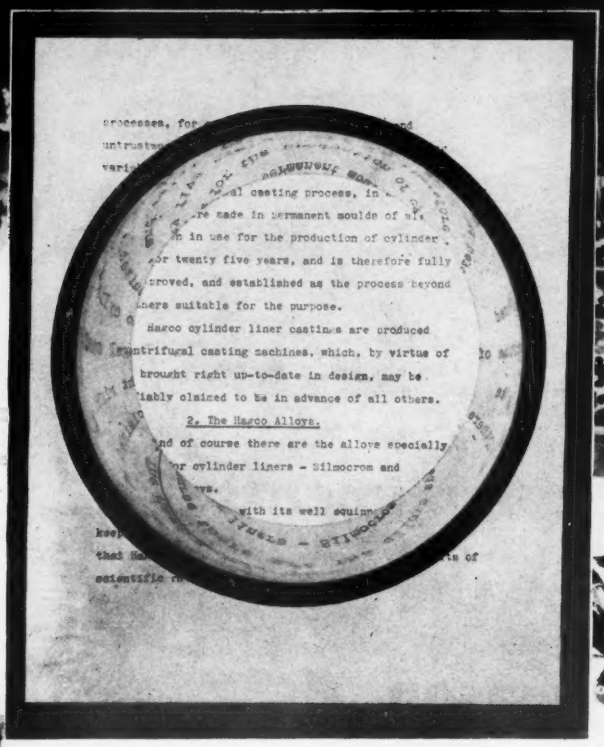
BURY FELT

Send your enquiries to:
BURY FELT MANUFACTURING COMPANY LIMITED
HUDCAR MILLS, BURY, LANCS; Phone: Bury 2262 (6 lines)
or to the London Office: 3 Snow Hill, E.C.1. Telephone: Central 4448

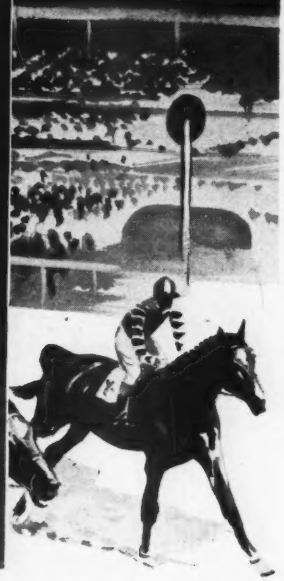
37

PHOTO "FINISH"

proves them well ahead . . .



OVERHEADS MAINTENANCE RUNNING COSTS . . .



The above photograph of the bore of a HAGCO Liner *after 120,000 miles* graphically shows how the iron has taken such a beautiful "mirror" polish that it reflects perfectly a page of typewriting looked at through the Liner. Conclusive proof to all motor engineers of the infinitesimal wear, and the outstanding resistance to abrasive action, of HAGCO "Silmocrom" and "Austenitic" Cylinder Liners.

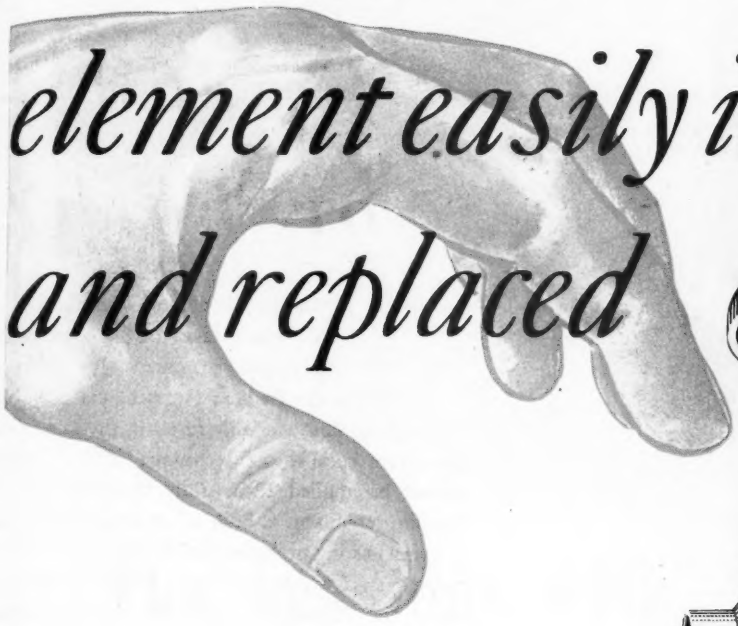
HAGCO
Cylinder
LINERS

Stellited Valves & Valve Seatings

HAROLD ANDREWS GRINDING CO., LTD., BRISTOL ROAD, BOURNBROOK, BIRMINGHAM, 29. *Telephone : SELly Oak 1128-9-0.* **and at MANOR WORKS, MANOR LANE, HALESOWEN.** *Telephone : HALesowen 1181-2.*

Detachable oil filter

element easily inspected and replaced



This new AC partial-flow oil filter with replaceable element meets the increasing demand for a filter that can be removed for inspection and replaced every 8/10,000 miles. It provides a permanent installation for coupling into a by-pass oil supply system and the filtering element can be replaced without disturbing pipe connections. Sump oil is filtered on an average of ten times an hour. This means less motor wear and longer motor life — the objective of every motor manufacturer.

AC

AIR CLEANERS · AIR SILENCERS · CRANKCASE BREATHERS
CAR HEATERS · FUEL PUMPS · SPEEDOMETERS · GAUGES
INSTRUMENT PANELS · OIL FILTERS · THERMOSTATS
SPARK PLUGS · WINDSCREEN WIPERS · DIE CASTING

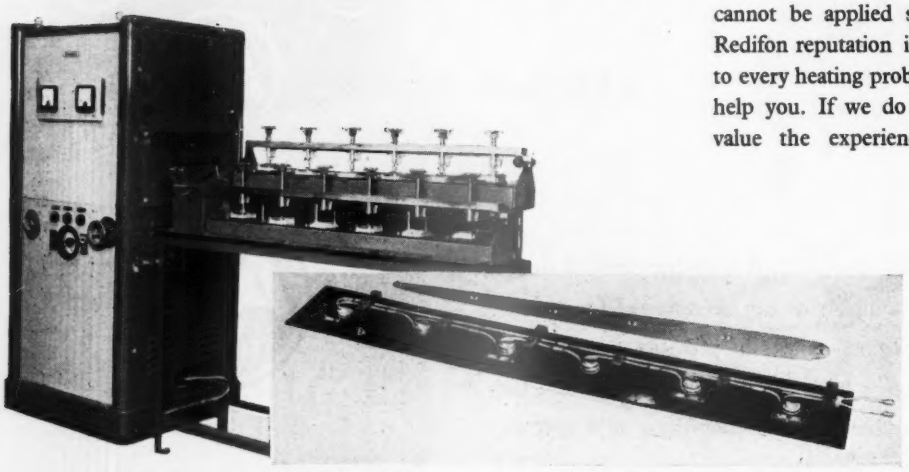
If you are contemplating an important new design, or a modification of an existing one, take advantage of the facilities of the AC Technical Bureau. We probably can save you hours of planning and experimentation. Write to the AC Technical Bureau, 54, The Butts, Coventry; or telephone Coventry 61747.

AC-SPHINX SPARK PLUG COMPANY,
DIVISION OF GENERAL MOTORS LTD.,
DUNSTABLE, BEDFORDSHIRE

Brazing bushes on chassis cross-members—both ends simultaneously.

Customers, Friends— or both?

One production problem solved and two more take its place, sometimes from the same customer. It's often like that in the Redifon Applications labs. The enquiries do not invariably result in the sale of more generators because the technique of R.F. Heating cannot be applied successfully in every case. The Redifon reputation is built on an impartial approach to every heating problem. Let us find out if R.F. can help you. If we do not make a sale we shall still value the experience—and the friendly contact.



Soldering of six studs to bonnet flute simultaneously—two-station working.

Brazing of petrol filler assemblies—four joints simultaneously, and two station working.

Some of the successful applications of R.F. Induction heating developed for a Redifon customer (one of England's biggest manufacturers of motor cars) are illustrated here. R.F. Induction heating lends itself particularly to local hardening or annealing, soft soldering and brazing.

Redifon

HEATING

INDUSTRIAL ELECTRONICS DIVISION

REDIFON LIMITED, BROOMHILL ROAD, WANDSWORTH, LONDON, S.W.18

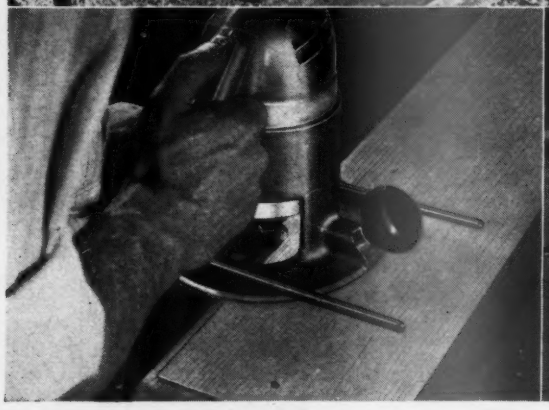
Designers and Manufacturers of Industrial Electronic and Radio Communication Equipment

BRIDGES OF LONDON

PORTABLE ELECTRIC

Router

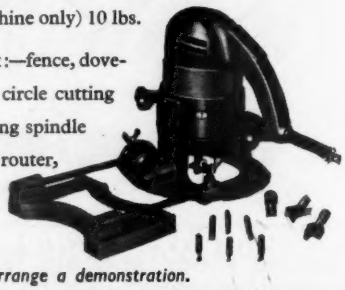
FOR GROOVING, MOULDING, ROUTING & RABBETING IN WOOD AND METAL ALLOYS



The Bridges Router is designed for easy working. A large aperture gives an unrestricted view of the work. There is a simple depth-of-cut adjustment. Changeover from one cutter to another takes only a couple of minutes.

SPECIFICATION

- Motor ¾ h.p. (AC/DC universal voltages 110, 200-220, 230-250).
- Full load current 3.5 amps. Max. size of cut ¾″ dia. × ¼″ deep in wood. ¼″ × ⅛″ in metals.
- Spindle speed (no load, 20,000 r.p.m.) full load 10,000 r.p.m.
- Collets to suit ¼″, $\frac{5}{16}$″ and ⅜″ dia. cutters shanks.
- Max. vertical movement of spindle 1″.
- Net weight (machine only) 10 lbs.
- Extra equipment:—fence, dovetailing attachment, circle cutting attachment, moulding spindle attachment, bench router, radial arm bench router.



The best tool dealers in your town stock the Bridges Router, and will be pleased to arrange a demonstration.

S. N. BRIDGES & CO. LTD., BRIDGES PLACE, PARSONS GREEN LANE, LONDON, S.W.6. (RENown 1177/8).

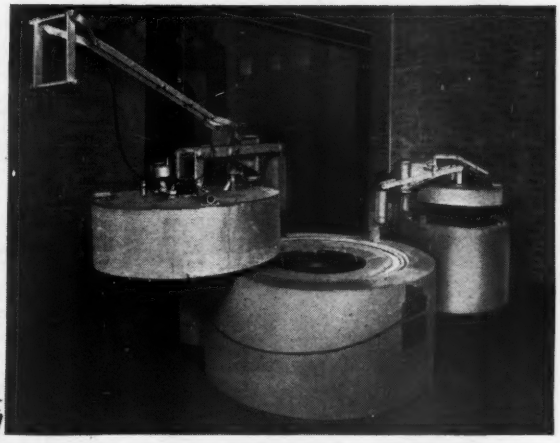
Case Hardening Steel...

with the NEW G.E.C.

CARBO-NITRIDING EQUIPMENT

★ Both carbon and nitrogen from a gas atmosphere are introduced into the surface of the steel at a temperature normally between 800 C. and 875 C. The steel is then cooled at the rate required to give the desired properties.

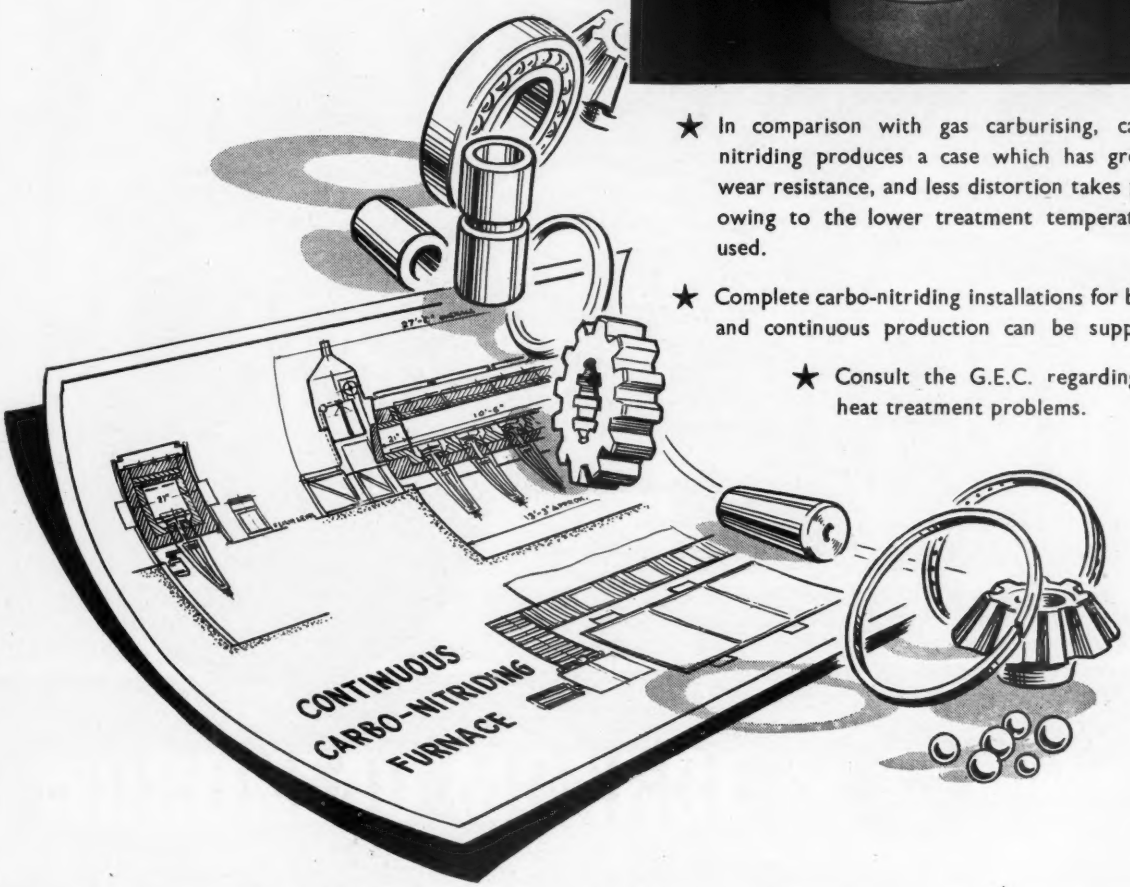
★ The process is cheaper than liquid cyaniding and the case composition as well as depth can be controlled. Cyanide waste is eliminated.



★ In comparison with gas carburising, carbo-nitriding produces a case which has greater wear resistance, and less distortion takes place owing to the lower treatment temperatures used.

★ Complete carbo-nitriding installations for batch and continuous production can be supplied.

★ Consult the G.E.C. regarding all heat treatment problems.



THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

MADE BY THE PIONEERS IN PRECISION STEERING GEARS

THE 'MARLES' DOUBLE-ROLLER GEAR, made in a range of sizes covering every type of chassis.

EFFORTLESS STEERING AND GREAT DURABILITY

Hardened cam and roller.

Tapered roller bearings (with detachable cones on the larger sizes).

Double bearing support to rocker shaft.

End-location adjustable.

Large angular movement.

Very compact box.

For fore-and-aft or transverse layout.

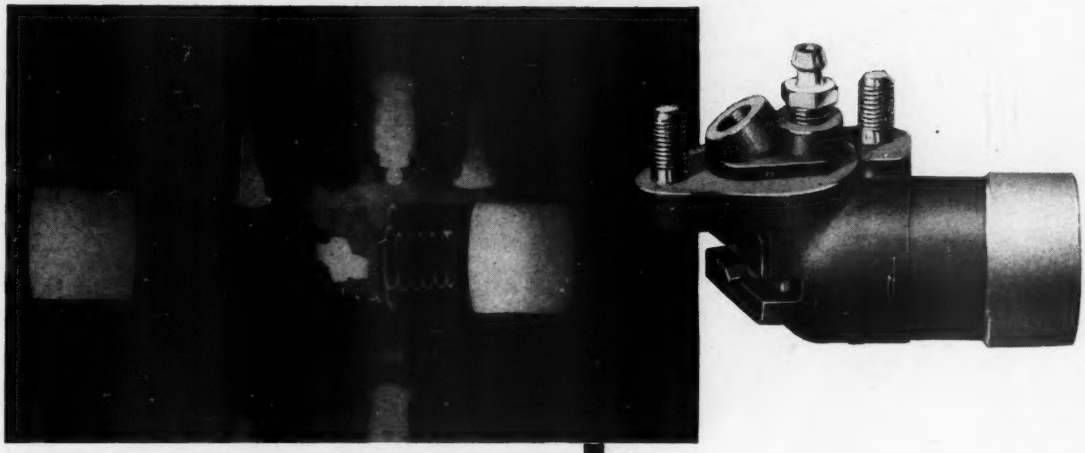
Trunnion or spigot mounting alternative on heavy types.

MARLES

ADAMANT

ENGINEERING CO. LTD., DALLOW ROAD, LUTON
Sole proprietors of the Marles Steering Company Ltd.

Telephone: LUTON 2662 (4 lines). *Telegrams: ADAMANT, PHONE, LUTON*



THIS X-RAY PHOTOGRAPH OF A HYDRAULIC CYLINDER SETS A NEW STANDARD IN BRAKE EFFICIENCY ..

every detail of production is the result of intense investigation by the Research, Design and Development Departments of this organisation.

It's the unremitting effort of ***Research and Development*** *that keeps*

GIRLING

THE BEST BRAKES IN THE WORLD

way out ahead

GIRLING LTD • KINGS RD • TYSELEY • BIRMINGHAM 11

Welding of 'elevators' for harvesting machinery by Messrs. Fisher and Ludlow Ltd., Erdington

Electric Welding

WELDING is one of electricity's most revolutionary processes. Compared with riveting, it shows a man-power saving which is almost incredible. You can build your structure from a plate or sections instead of casting it or machining it from the solid. *Electric welding saves time, power and greatly increases output.*

WHERE TO GET MORE INFORMATION

Your Electricity Board will be glad to help you to get the utmost value from the available power supply. They can advise you on ways to increase production by using Electricity to greater advantage — on methods which may save time and money, materials and coal, and help to reduce load shedding. Ask your Electricity Board for advice : it is at your disposal at any time.

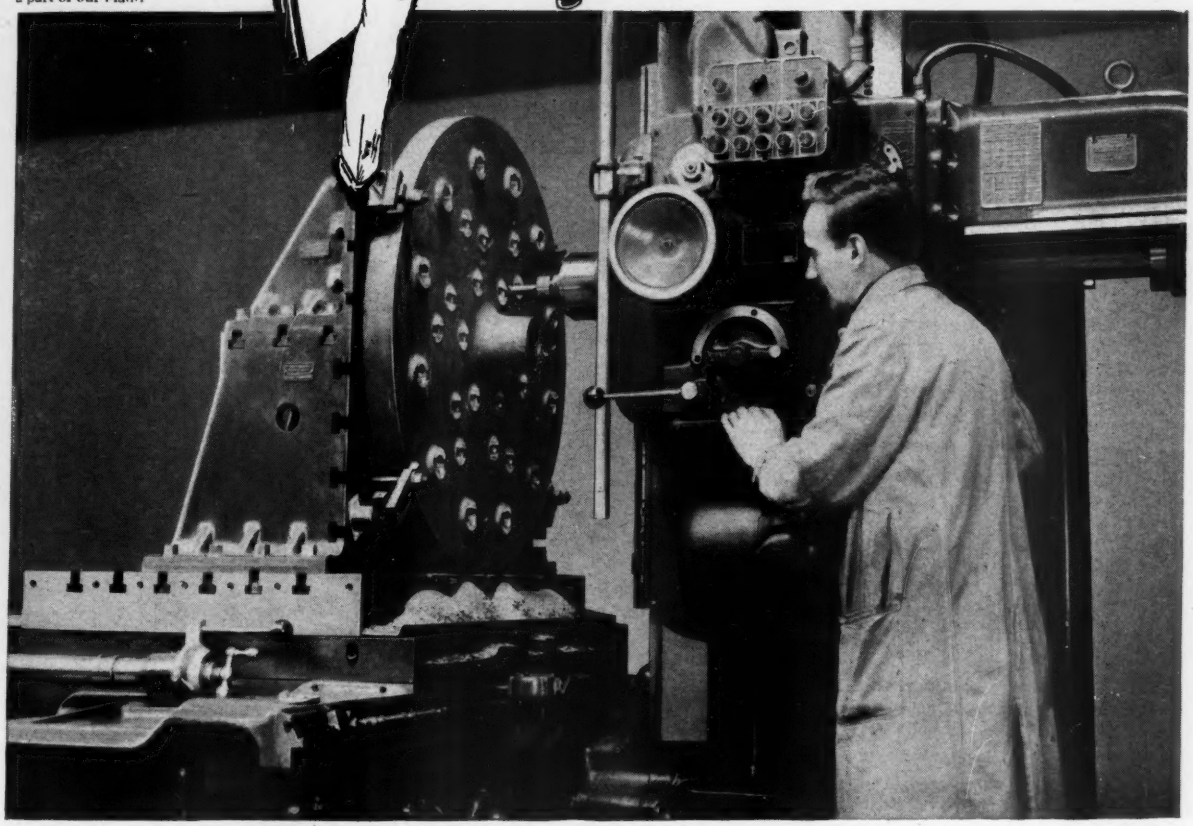
Electricity for PRODUCTIVITY

Issued by the British Electrical Development Association.

out of our ivory tower . . . .

Normally we are sufficient unto ourselves. We make the tools and many of the machine tools that make Holroyd Worm Gears, because this way we can be sure of living up to our very high standards of accuracy. But now and again we have to emerge from our ivory tower long enough to find a machine for a specific job — a machine we prefer not to make ourselves. We take any amount of trouble and put our hands deep into our pockets to secure the right one. Which attitude is why Holroyd Worm Gears are good enough for us to be boastful abou*.

The illustration shows one of the two De Vlieg Production Jig Boring Machines which form a part of our plant.



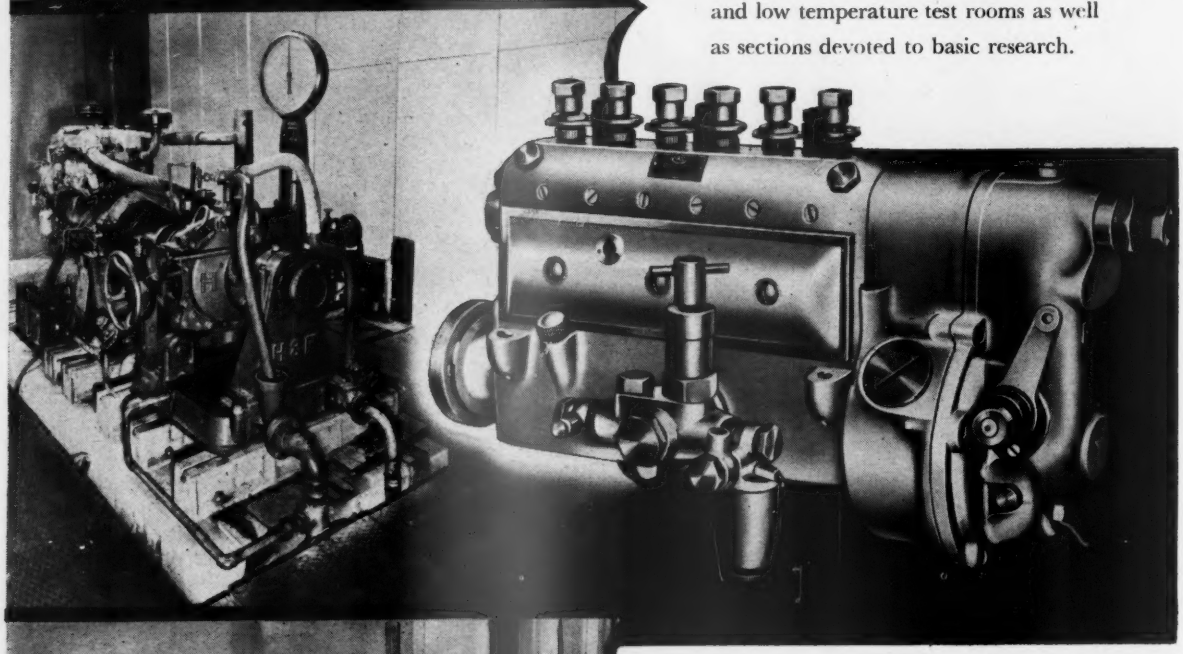
Holroyd WORM GEARS

JOHN HOLROYD & COMPANY LIMITED · MILNROW · LANCASHIRE

CRC 155

Research . . .
Development . . .
Craftsmanship . . .

C.A.V. Fuel Injection Equipment is backed by intensive work in some of the finest laboratories in the country, comprising physical, metallurgical, X-ray and fuel injection development divisions, engine dynamometer test beds, humidity and low temperature test rooms as well as sections devoted to basic research.



In the production of the elements of C.A.V. Fuel Injection Pumps, the workmanship represents what is probably the highest standard attained in any branch of precision engineering. Clearance between a pump barrel and its plunger is approximately 1 micron (0.00004 in.), whilst the surface of plunger is finished by hand lapping to within 1.5 micro-inches (1 micro-inch is one millionth of an inch).

C.A.V.

Fuel Injection and Electrical Equipment

C. A. V. LIMITED, ACTON, LONDON, W. 3

174-441

COMMER

VULCAN

THORNYCROFT

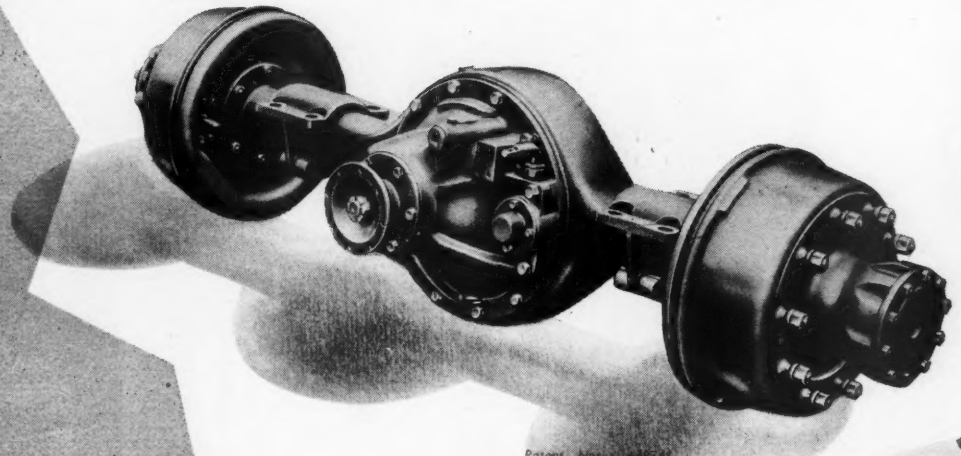
Leyland

GUY

ALL THESE FAMOUS MAKERS FIT

EATON 2-Speed AXLES

Seddon



Patent Nos: 609031, 613231, 616539

BEDFORD

DODGE

RAPIER
RANSOMES & RAPIER LTD

AUSTIN

DENNIS

VOLVO
BELGIUM

OVER A MILLION EATON TWO-SPEED AXLES IN TRUCKS TO-DAY

EATON
2-Speed AXLES

The fact that many well-known manufacturers fit EATON 2-Speed AXLES to appropriate models reflects the increasing demand for commercial vehicles with two complete speed and power ranges.

The HIGH ratios—equal to an overdrive for every gear—save time and fuel on fast work, while the LOW ranges give a power reserve for difficult conditions. Moreover the EATON 2-Speed AXLE enables the engine to maintain its most economical running speed always. *Write for full particulars.*

100% BRITISH MANUFACTURE

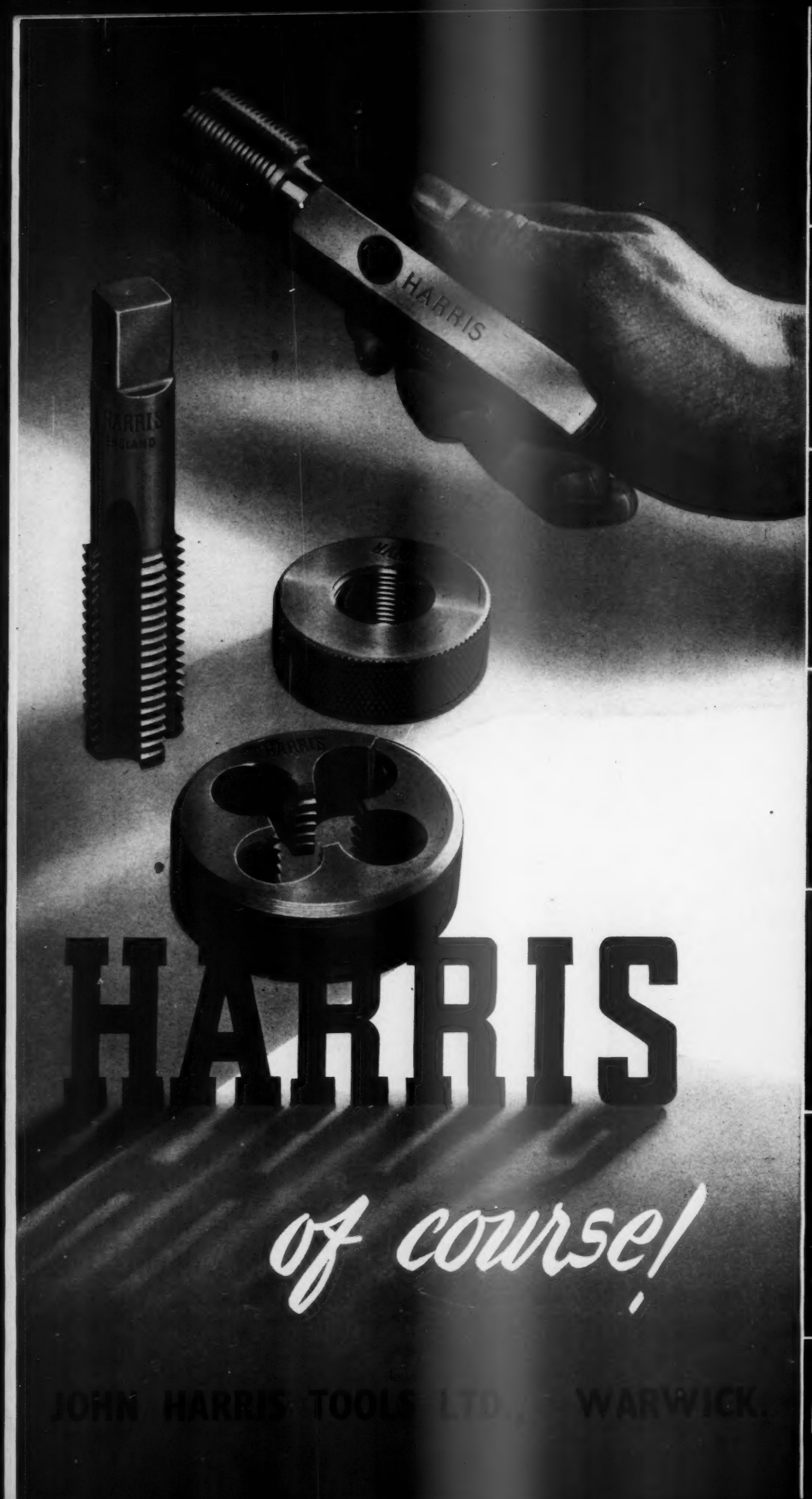
STOCKS OF SPARES AVAILABLE IN ALL PARTS OF THE WORLD

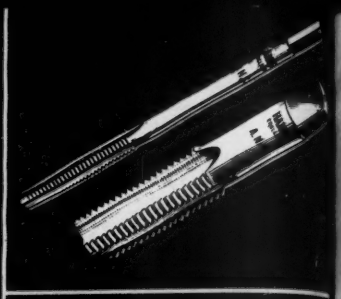
EA21

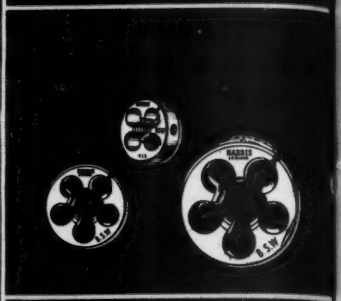
EATON AXLES LIMITED · 25 VICTORIA ST · LONDON S.W.1 · ENGLAND

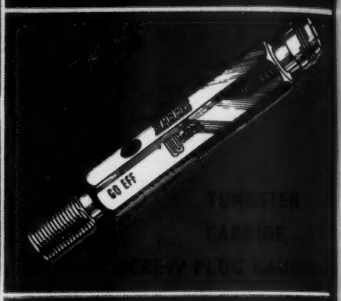
In association with—EATON MANUFACTURING CO., CLEVELAND, OHIO, U.S.A · E.N.V. ENGINEERING CO. LTD., LONDON, N.W.10 · RUBERY OWEN & CO. LTD., DARLASTON

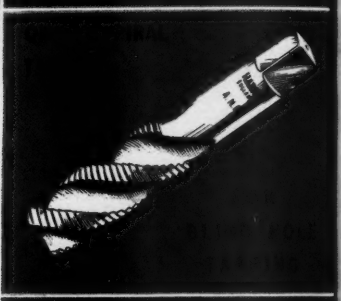
Telephone: ABBEY 6471

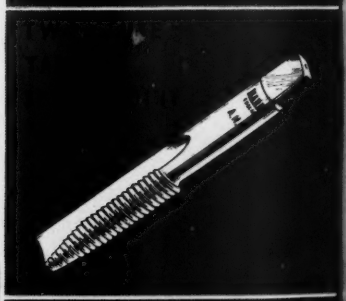


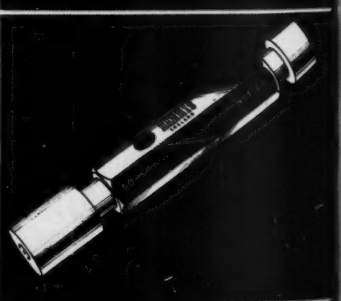








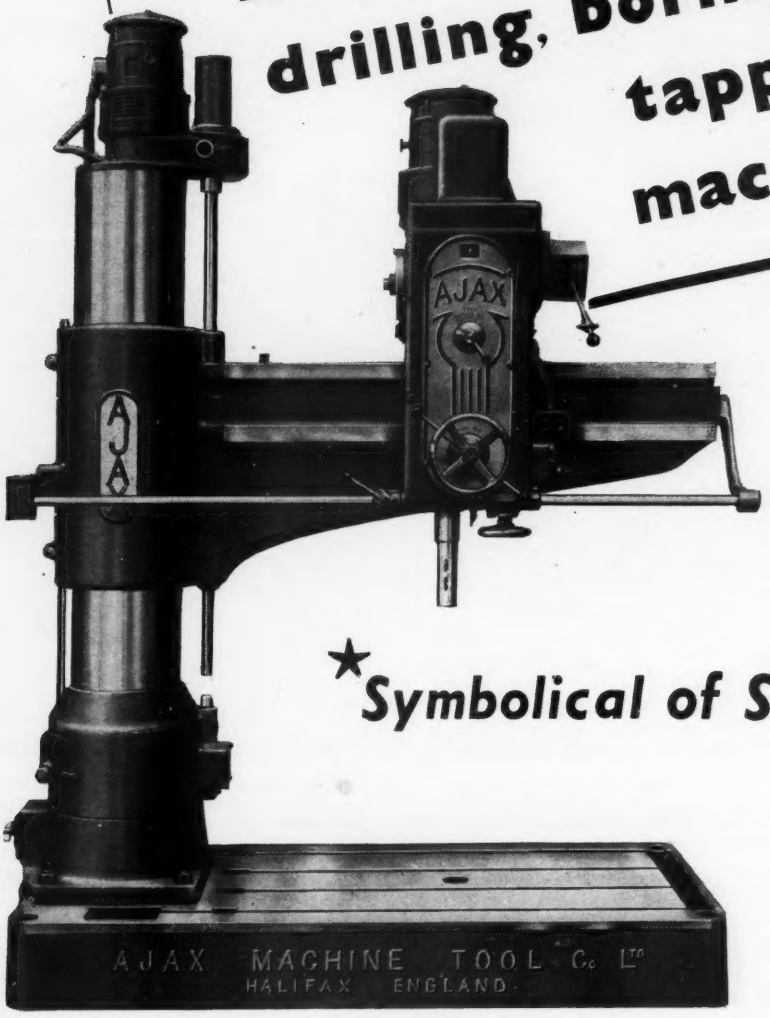




JOHN HARRIS TOOLS LTD. WARWICK.

phone: 741 (4 lines)

★AJAX radial drilling, boring & tapping machine

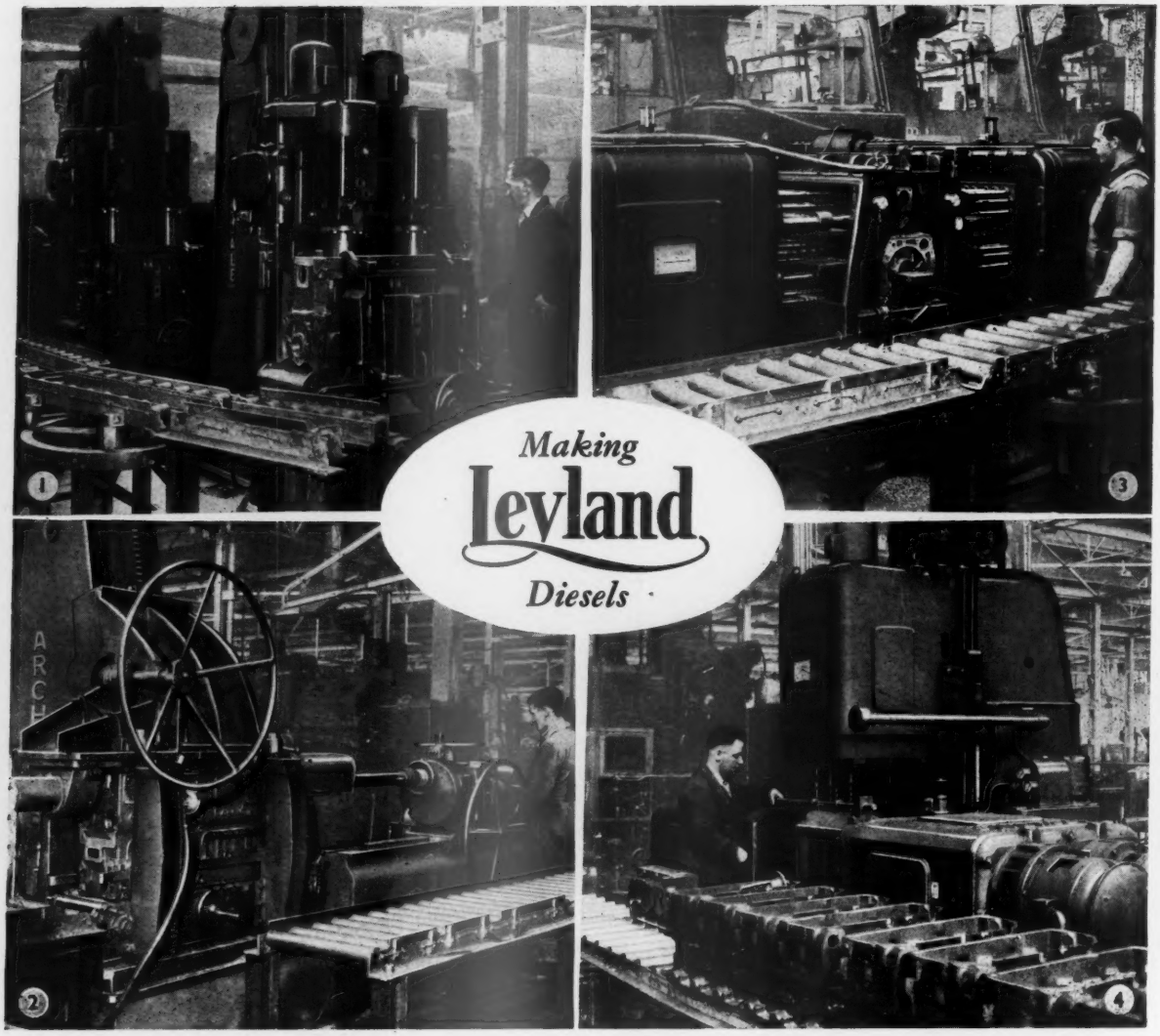


★Symbolical of Strength

4′ 6″, 5′ and 5′ 6″ sizes.
3′, 3′ 6″ and 4′ saddle traverses.
8 speeds in choice of 3 ranges.
4 rates of power feed at each speed.
1⅝″ dia. spindle with 14″ feed.
3″ capacity in cast iron.
Completely electrified. No friction clutches.

Write for leaflet AJ4 to:
Ajax Machine Tool Co. Limited,
West Mount Works, Halifax, Yorks.
Proprietors: ADA (Halifax) Ltd.

AJAX MACHINE TOOLS



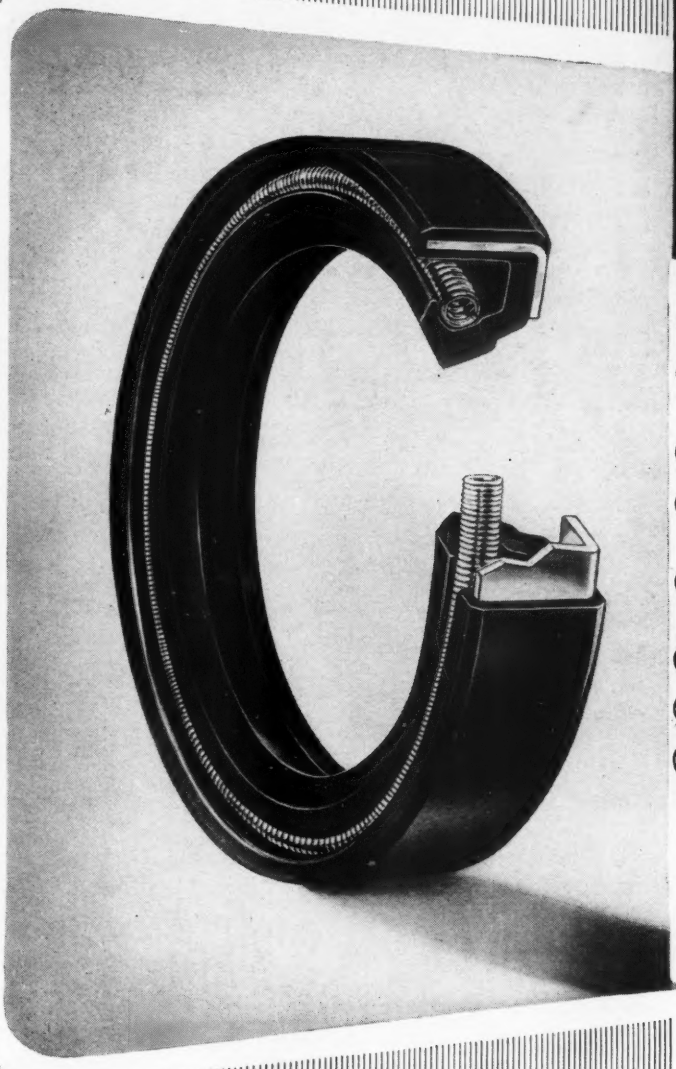
1. Finish boring bores in cylinder block for cylinder liners. Snout type robust spindles spaced for cylinders 1 and 4, the component being indexed for bores 2 and 5, 3 and 6, by the precision longitudinal indexing table.
2. One of four machines for boring and drilling operations on crankshaft, camshaft and idler gear bores.
3. Drilling both sides of cylinder blocks simultaneously, 111 spindles in operation, 43 on the water face, 68 on the tappet face.
4. Drilling, combustion face, rocker face manifold face and one end face of cylinder head. Machine heads have 29, 36, 13 and 2 spindles respectively.

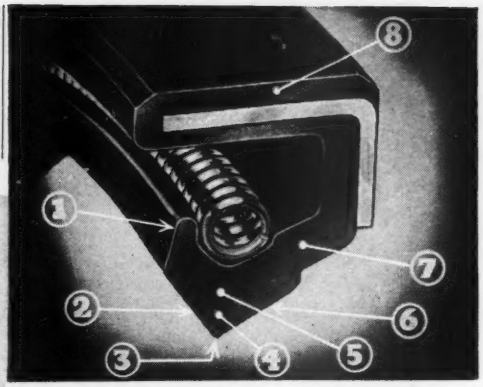
ARCHDALE *SPECIALS*

for high production in the automobile industry

JAMES ARCHDALE & CO. LTD., LEDSAM STREET, BIRMINGHAM, ENGLAND

SOLE SELLING AGENTS: ALFRED HERBERT LTD., COVENTRY & BRANCHES





1. Deep rim affords perfect Spring Retention.
2. Large Face Angle brings Sealing Edge well below spring.
3. Knife Edge Contact at Sealing Point.
4. Sealing Point stiffened against local deformation by large included angle.
5. This section stiffened to prevent deformation under load.
6. Shaft angle gives adequate clearance.
7. Flexible Web.
8. Gaco Skin affords better fluid tight fit in housing.

"HAIRLINE" LIP CONTACT!

THE

GACO M.I. OIL SEAL

[British Patents 478136, 479743]

The Scientifically Designed Oil Seal which is now the accepted standard for Rotary Shaft Oil Retention. Made of GACO!

ANGUS OIL SEALS

Fluid Sealing Engineers

GACO

REGD. TRADE MARK

GEORGE ANGUS & Co LTD

Zinc alloy die casting makes all the difference!

A glance will show the improvement in design which resulted from the introduction of zinc alloy die castings for the working parts of this butter churn.* All the parts above the lid of the glass jar, except the spindles and screws, are die cast in zinc alloy. It is an excellent example of the result of close co-operation between designer and die caster.

Compared with the old cast iron model, the new one is more compact, less liable to breakage, lighter and cheaper.

An improved finish is possible—sprayed aluminium paint being used on this model. And production is simplified because no machining is required.

*Reproduced by courtesy of J. J. Blow Ltd.

Some facts about zinc alloy die casting

Speed of production is an outstanding feature of the die casting process — the shortest distance between raw material and finished product. Zinc alloys are the most widely used of all metals for die casting because they yield castings with the following qualities:

ACCURACY: Castings can be made practically to finished dimensions and need little or no machining.

STRENGTH: Good mechanical properties for stressed components.

STABILITY: Close tolerances are maintained throughout the life of the casting.

British Standard 1004

It is essential that alloys conforming to B.S.1004 should be specified for all applications.

The Association welcomes enquiries about the use of zinc alloy die castings. Publications and a list of Members are available on request.

ZADCA **ZINC ALLOY DIE CASTERS ASSOCIATION**

LINCOLN HOUSE, TURL ST., OXFORD

Do you want a second opinion?

The first issue of The Nickel Bulletin was sent out 21 years ago. Ever since, month after month, it has found its way to the desks of metallurgists, chemists, engineers, works managers and many others concerned with the production or use of metal. Its abstracts of current published information provide a valuable second opinion whenever nickel and its alloys are being considered. You can have the Nickel Bulletin constantly at your elbow by asking to be put on the mailing list now. There is no charge.

MOND NICKEL

THE MOND NICKEL COMPANY LTD · SUNDERLAND HOUSE · CURZON STREET · LONDON · W1

MORE about the METACONE*

In a previous advertisement we pointed out the several factors which combine to give the high load capacity and retention of resilience of our patent **'METACONE'** mountings.

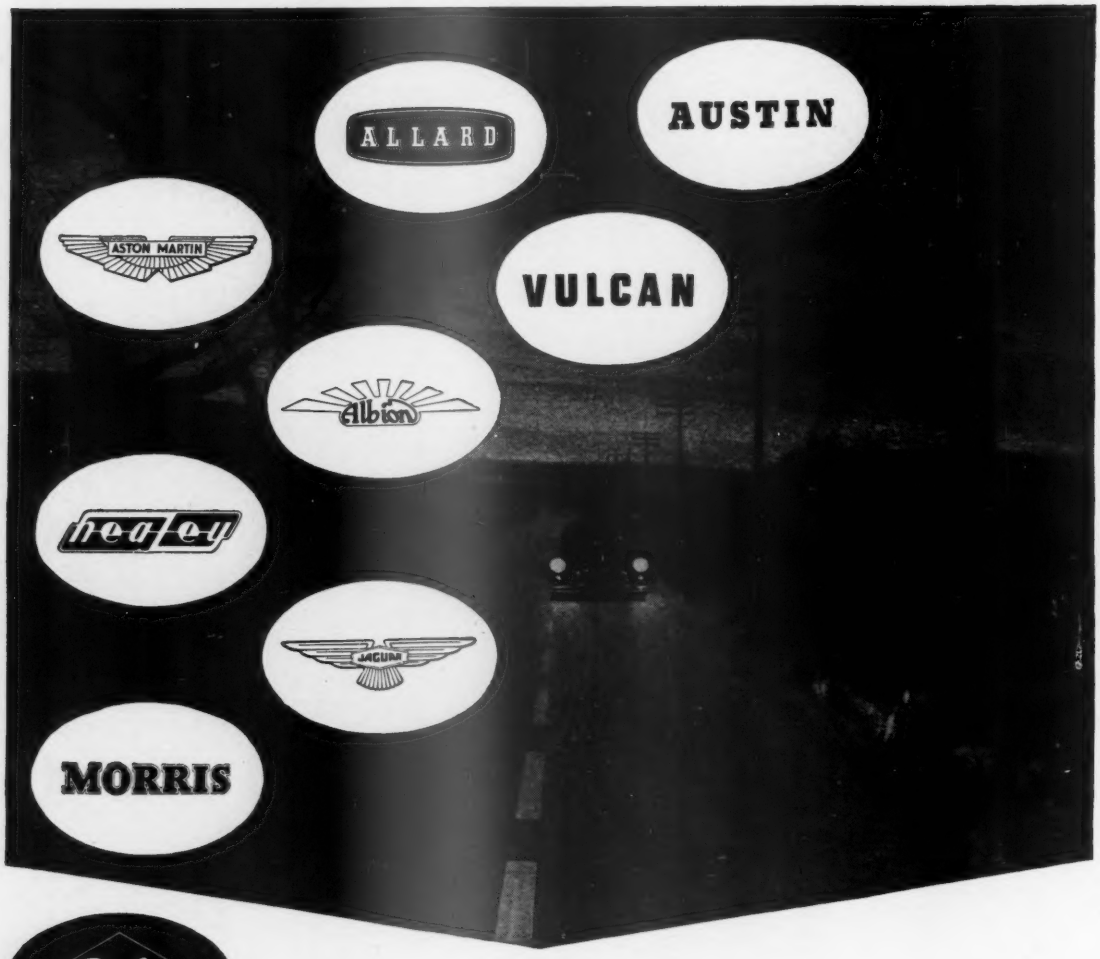
These features include, first and foremost, the use of specially-formed inner and outer sleeves, to both of which the rubber is bonded by the famous Metalastik rubber-to-metal weld, utilizing the rubber to the best advantage in compression as well as shear, and moreover, avoiding creep and consequent permanent set, the enemies of high loading and consistent performance.

This successful design, developed by a wealth of technical resources and carried into practice by our exclusive manufacturing process, is available in the special type illustrated, where the rate is greater in one horizontal direction than the other, a valuable feature in many applications.

These mountings were designed expressly as engine mounting units but are suitable also for other vibration absorbing applications where the main load is in the vertical direction. The two different horizontal stiffnesses can be used to combine lengthwise constraint with transverse freedom and the built-in bump and rebound stops absorb the starting and stopping kick and prevent overload.

*Trade Mark

METALASTIK



Riley

MORRIS-COMMERCIAL

JOWETT

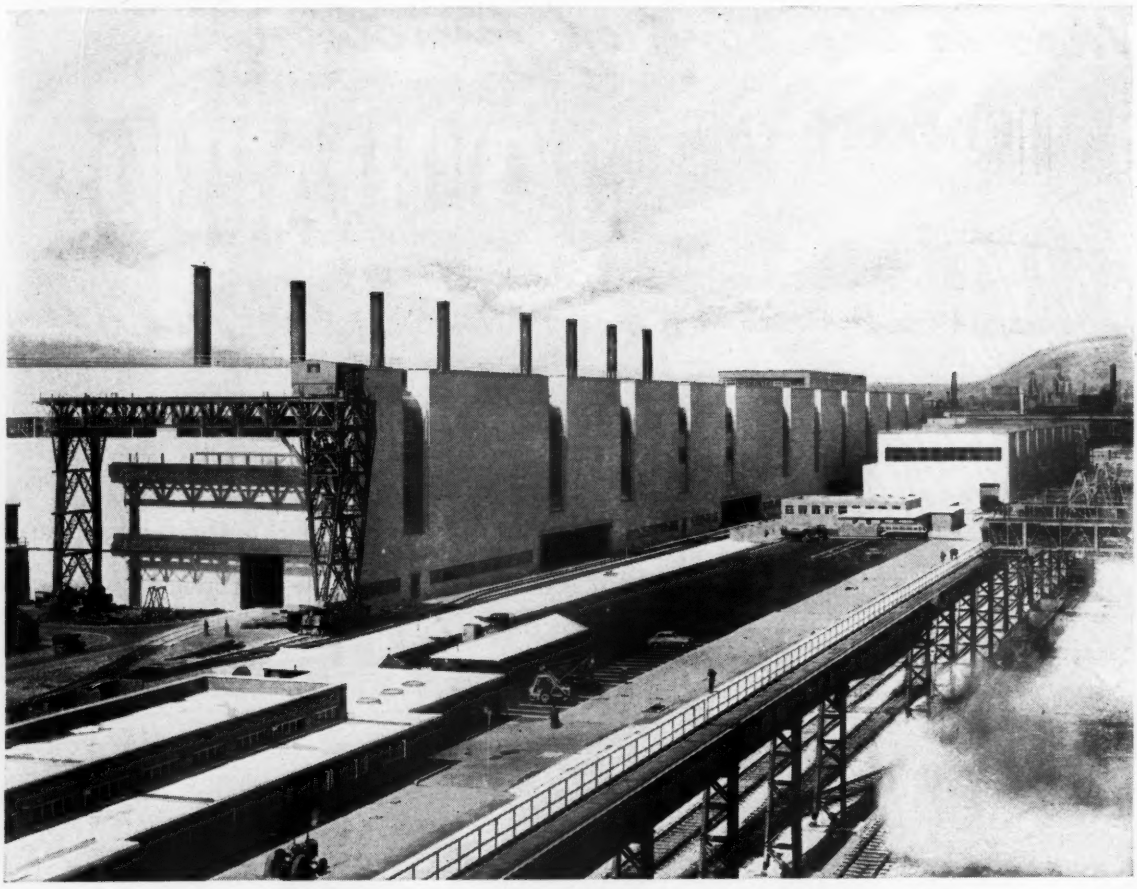
DENNIS

MINTEX — famous in its own right — is proud of its association with other famous names. Shown here are the names of vehicles produced by manufacturers who win prestige for Britain throughout the world, and who use MINTEX Brake Liners as original equipment.

For complete reliability you can depend on

MINTEX

MINTEX BRAKE & CLUTCH LINERS are manufactured by BRITISH BELTING & ASBESTOS LTD., CLECKHEATON YORKSHIRE and are obtainable from all Mintex Service Depots and stockists.



General View of Abbey Works

THE ABBEY WORKS, built adjacent to the existing Works, consists of a Melting Shop, 80″ Continuous Hot Strip Mill, Three-Stand Cold Reduction Mill and ancillary plant.

PRODUCTS OF THE COMPANY ARE :—

Hot Rolled and Cold Reduced Sheets and Coils up to 72″ sheared width in qualities for auto-bodies, vitreous enamelling, extra deep drawing, etc. · Galvanized Flat and Corrugated Sheets · Electrical Sheets for Dynamos and Transformers · Blackplate · Hot and Cold Reduced Tinplate both hot dipped and electrolytically tinned · Plates $\frac{1}{8}$″ thick and upwards by up to 72″ wide · Flange, Bullhead and Bridge Rails · Fishplates · Steel Railway Sleepers · Sections · Slabs · Basic Pig Iron · Coke and By-Products · Sized Limestone.

Export Sales Organisation for Mild Steel Flat Rolled Products

RTSC EXPORTS LIMITED

47 PARK STREET, LONDON, W.1.

THE STEEL COMPANY OF WALES LIMITED

ABBEY WORKS · PORT TALBOT

Remember this?

Two years ago we issued this challenging advertisement with the knowledge that, even in these difficult days, we had the organisation and stock to cope with all demands. Since then, Monks and Crane have made remarkable progress—***"The Twist Drill Specialists"*** are now known throughout the engineering industry as ***"The Small Tool Specialists".***

Today, despite increasing difficulties and the heavy demands made upon us, we are still ready to back our organisation against any challenge you may care to make.

Britain's Foremost Distributors—
still supply the goods.

MONKS & CRANE LTD
THE TWIST DRILL SPECIALISTS

London Office:
295, EUSTON ROAD
LONDON, N.W.1
Tel: Euston 5311 (3 lines)
Grams: Emancee, London

Head Office:
STANHOPE STREET
BIRMINGHAM · 12
Tel: CALthorpe 1381 (5 lines)
Grams: Emancee, Birmingham

Manchester Office:
MANCHESTER OLD ROAD
RHODES : MANCHESTER
Tel: Middleton 3654 (3 lines)
Grams: Emancee, Middleton, Manchester

SM/MC 499b

INDUCTION HEATING EQUIPMENT

Brings high speed flow-line production to soldering, brazing and heat treatment operations

COMPACT EQUIPMENT occupies minimum floor space.

INFINITELY VARIABLE POWER CONTROL by means of a single knob (7½ and 25 kw. units).

FULLY PROTECTED CIRCUITS with tell-tale indicator lights (7½ and 25 kw.).

AUTOMATIC SHUT-DOWN PROTECTION should water and air circulation become insufficient.

SILICA ENVELOPE VALVES, guaranteed for 1,500 working hours, can be repaired, reducing by 50% normal cost of valve replacement.

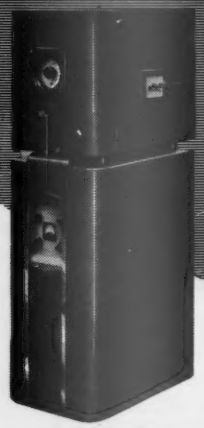
EASY SERVICING. Equipments are unit-built and factory-built replacements can be installed as sub-assemblies.

Output power: 25 kw. continuous, 35 kw. at 50% duty cycle with a maximum heating time of 8 seconds. Output frequency: 250-600 kcs. Power supply: Standard voltage 50/60 cycle, three phase, four wire. Power consumption: 50 kw. at full output, 4 kw. on standby. Power factor: 0·87 at full load.

25 KW.

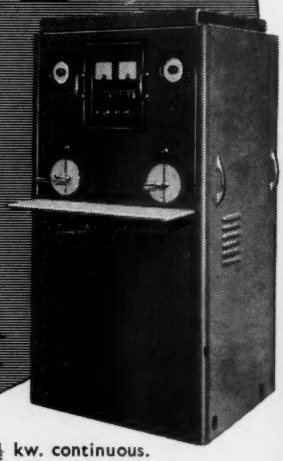
TWO STATION SWITCH

Can be incorporated in any equipment, and speeds flow line production on many heating jobs. One station can be loaded whilst the heating cycle is in progress at the other and, if necessary, two dissimilar jobs can be treated on the same production run.



1 KW.

A compact unit suitable for numerous soft soldering, brazing and hardening applications. When delivering 1 kw. main loading is approx. 2 kw. with a power factor of approximately 0·9. Suitable for connection to 200/250 v. single phase, 50 cycle supply.



7½ KW.

Output power: 7½ kw. continuous. Higher output can be obtained for short duty cycles. Output frequency: two m/cs. Power supply: standard voltage 50 cycle, three phase, four wire. Power consumption: 15 kw. at full output, 600 watts at standby. Power factor: 0·9.

SPECIALISTS IN MECHANISED INDUCTION HEATING

APPLIED HIGH FREQUENCY LTD.

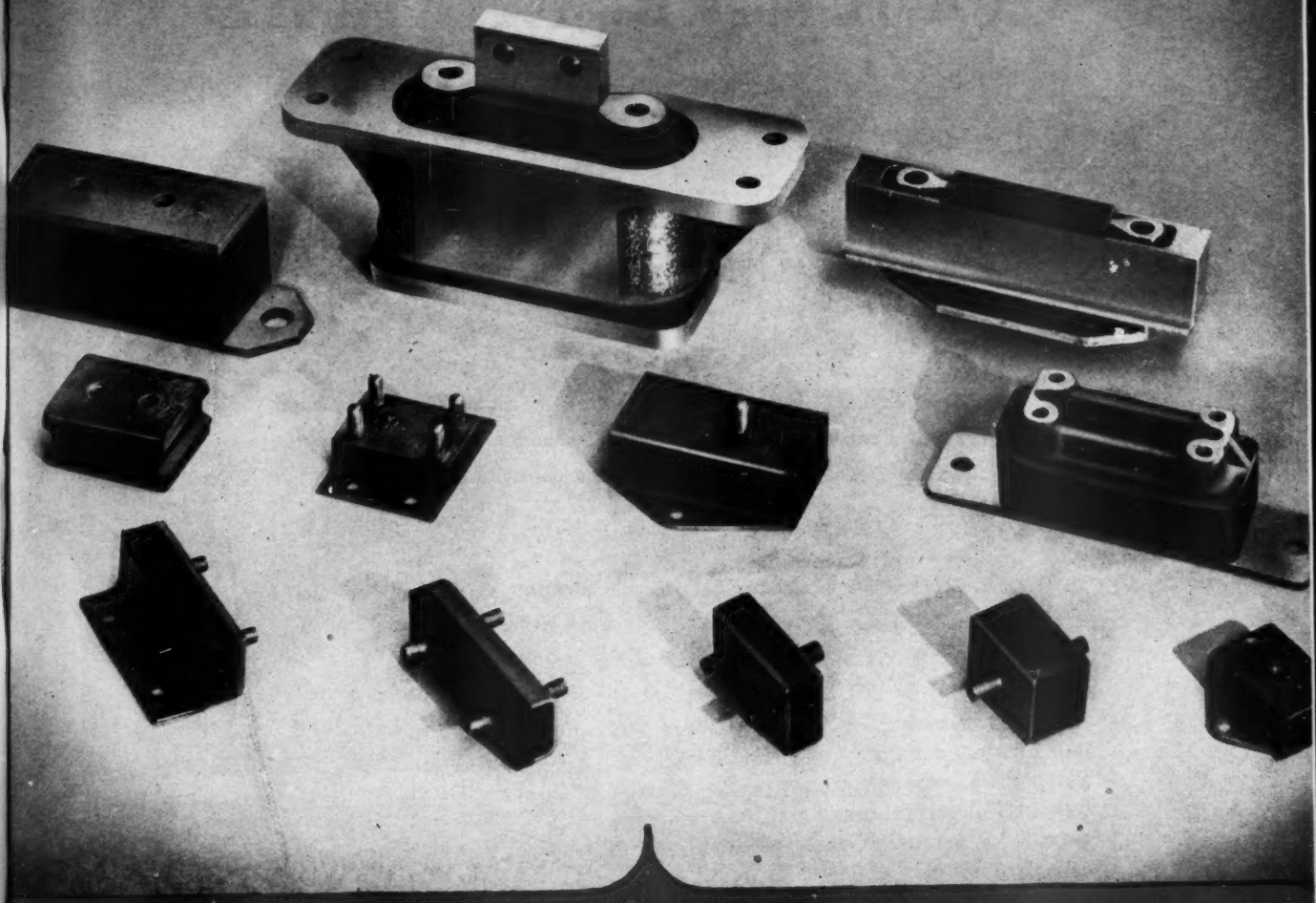
ACTARC WORKS, GOLDHAWK RD., LONDON, W.12

TELEPHONE: SHEPHERDS BUSH 1151

140 FI

INGENUITY IN

Rubber Bonded to Metal



Bonded Rubber Automobile Mountings

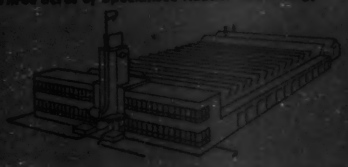
ANDRE RUBBER

★ For damping vibration in private car or heavy goods vehicle, the bonded rubber mounting provides a simple and effective answer.

As designers and producers of resilient mountings for the leading automobile manufacturers, ANDRE RUBBER can offer technical service and production facilities second to none.

If vibration is your problem—send it to us!

Three acres of Specialised Rubber Technology

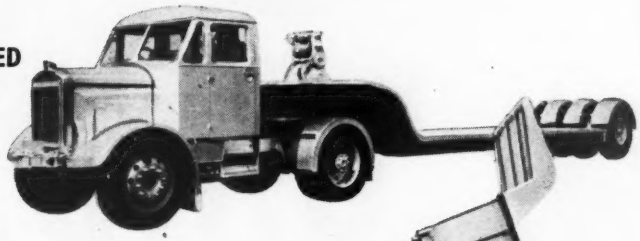


Write for a copy of "Elastomeric Engineering Examples"—a photographic record of the wide range of rubber and rubber/metal components produced by ANDRE.

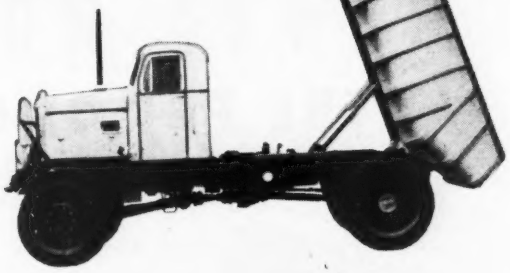
ANDRE RUBBER COMPANY LIMITED (A SILENTBLOC COMPANY)

KINGSTON BY-PASS, SURBITON, SURREY Telephone: ELMBRIDGE 6580/3 Telegrams: ANDRE SURBITON

SCAMMELL ARTICULATED
20-TON MACHINERY
TRANSPORTER

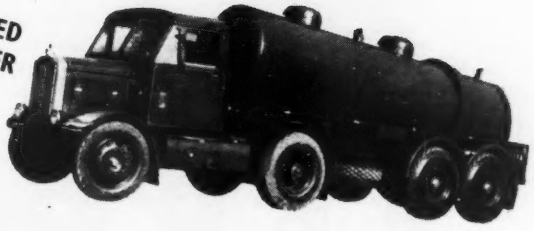


SCAMMELL 14-FT.
WHEELBASE
MOUNTAINEER



SCAMMELL SIX-WHEEL
DRIVE EXPLORER

SCAMMELL ARTICULATED
EIGHT-WHEELED TANKER



CAPASCO

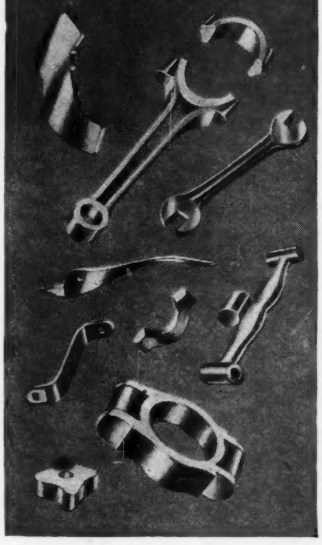
THE CAPE ASBESTOS COMPANY LIMITED

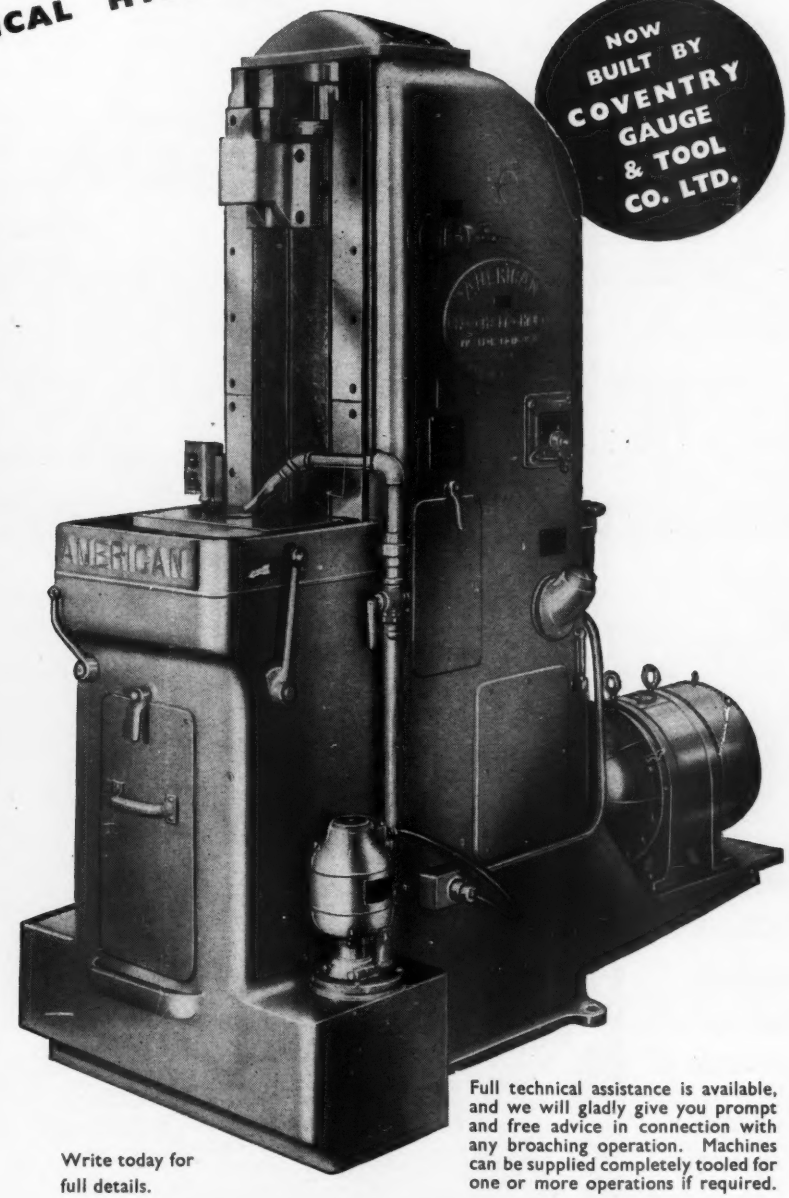
114-116 PARK STREET · LONDON · W1 · GROSVENOR 6022 P.B.X.

PUSH PULL SURFACE BROACHING WITH THE BRITISH AMERICAN 3-WAY VERTICAL HYDRAULIC BROACHING MACHINE TYPE 'T'

NOW BUILT BY COVENTRY GAUGE & TOOL CO. LTD.

FOR HIGH PRODUCTION OF FLAT ROUND OR ODD-SHAPED PARTS





OF American design and British workmanship, these "American" 3-way Vertical Hydraulic Broaching Machines are general purpose machines adaptable to many different operations including surface broaching, push down and pull down broaching for internal work.

Features include Hardened and Ground Ways, Removable Work Plate, Speed Control, Automatic Lubrication, Safety Control. These machines are easy to operate, are highly productive and very flexible in operation.

Sizes range from 4 to 8 tons capacity with 24" stroke and 6 to 15 tons capacity with 36" stroke.

Write today for full details.

Full technical assistance is available, and we will gladly give you prompt and free advice in connection with any broaching operation. Machines can be supplied completely tooled for one or more operations if required.

ROCKWELL
MACHINE TOOL CO. LTD.

WELSH HARP, EDGWARE ROAD, LONDON, N.W.2. Phone: GLADSTONE 0033

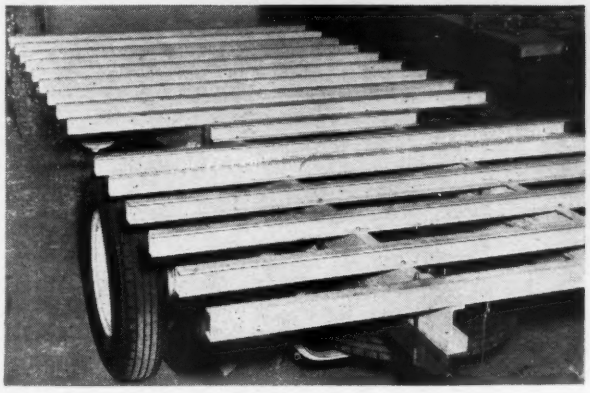
ABV 2

N21

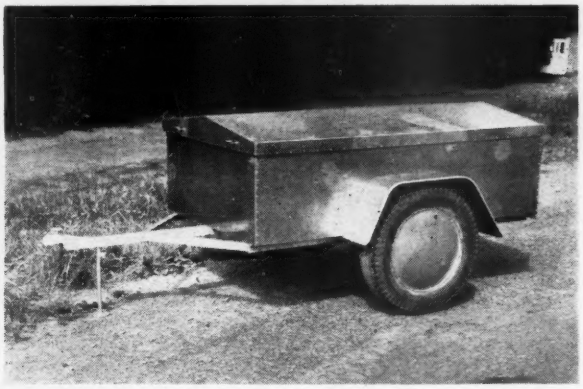
DURALUMIN
REGD. TRADE MARK

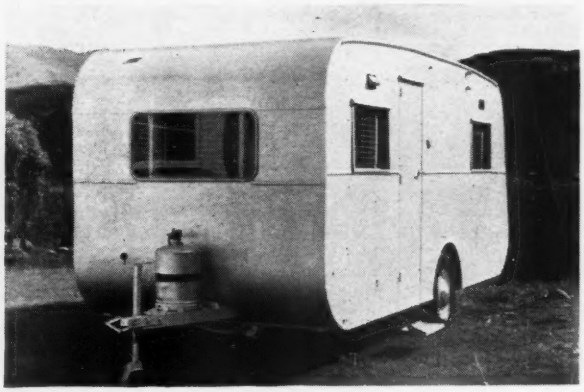
in New Zealand

Road transport in New Zealand presents special problems, and vehicles must be particularly strong to stand up to the arduous conditions. These photographs produced by courtesy of our New Zealand agents, Gas Turbines Ltd., 17/19, Wingfield Street, Wellington, N.I., show how 'Duralumin' is being used to solve these problems.



In this Leyland truck, shown in the two photographs above, 'Duralumin H' is used for the sides with stiffeners of folded top-hat section. This vehicle was required to operate under unusually adverse conditions of load and road, while enabling light gauge decking to be used. This accounts for the relatively close spacing of the bearers. Nevertheless, 'Duralumin' permitted an overall weight saving to be made, despite the somewhat unorthodox construction.





The 4-yard tip truck (top) has a floor of 6 SWG and sides of 10 SWG 'Duralumin H'. The resilience of this alloy is a great asset in handling heavy stone traffic.

In the camping trailer, the chassis members, tow bar and sheeting are all in 'Duralumin H'. The top cover of 18 SWG sheet requires very little effort to lift it.

In the caravan, the roof is of 20 SWG 'MG2' sheet, and uses neither rivets or screws: the edges of each sheet have folded interlocking lips. The sides of the roof are beaten down over the side panelling, and the construction is 100% watertight.

JAMES BOOTH & COMPANY LIMITED · ARGYLE STREET WORKS BOOTH BIRMINGHAM **BIRMINGHAM · 7**

The Timken Roller Bearing Company of Canton, Ohio, U.S.A.

... announces that by the judgment of the United States District Court for the Northern District of Ohio, Eastern Division, in the case of United States of America vs. The Timken Roller Bearing Company, our agreement with British Timken Ltd., of Birmingham, England, and with Société Anonyme Française Timken, of Asnières, France, granting to those companies the exclusive right to sell tapered roller bearings in certain territories for original installation and imposing certain conditions upon sales by us of bearings for replacement purposes in those territories, has been terminated, and renewal thereof prohibited.

We may hereafter make sales of tapered roller bearings in any territory free of the restrictions formerly imposed by virtue of such agreement.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO, U.S.A.

you can now secure

a better power-weight ratio

increased 'portability'

lighter reciprocating parts

AND 500% LONGER WORKING LIFE

by using

LIGHT ALLOY COMPONENTS

which, without any

electro-deposited undercoat,

are directly

HARD CHROMIUM PLATED

by

MONOCHROME

LIMITED

STUDLEY ROAD · REDDITCH · WORCS

Telephone : Studley 121/4

18556B

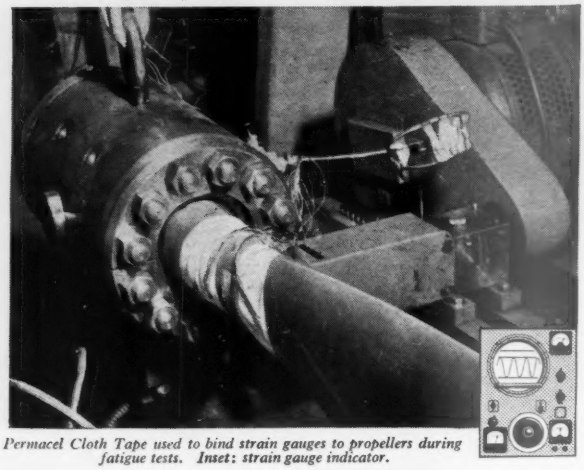
Abingdon **KING DICK** LTD

ABINGDON WORKS · KINGS RD · TYSELEY · BIRMINGHAM 11 · ENGLAND

R/E 119/1

For tenacity De Havilland's choose Permacel masking tapes

made by Johnson and Johnson



Permacel Cloth Tape used to bind strain gauges to propellers during fatigue tests. Inset: strain gauge indicator.

DURING HUNDREDS of hours of continuous vibration, the strain gauges attached to this aircraft propeller must stay precisely in position. That is why De Havilland's have chosen Permacel Cloth Masking Tape to bind them in place, for Permacel will adhere firmly to the smoothest surface. In addition to instant, sure adhesion, Permacel Cloth and Crepe Paper Tapes have two special advantages which lead to greater efficiency in production. They are resilient, and can be used effectively on sharp corners and irregular surfaces. They strip cleanly, leaving no sticky residue. The Paper Tapes, of course, are impervious to oils, acids and the chemicals normally used as solvents in paint and dope.

Permacel Cloth Tape used to fix paper masking on Comet wings and fuselage.

Stocks of all popular widths are available and orders for all sizes can be filled within the week.

Permacel

CELLULOSE SELF-SEALING TAPE

CLOTH AND 'DOUBLE BONDED'* CREPE PAPER MASKING TAPES

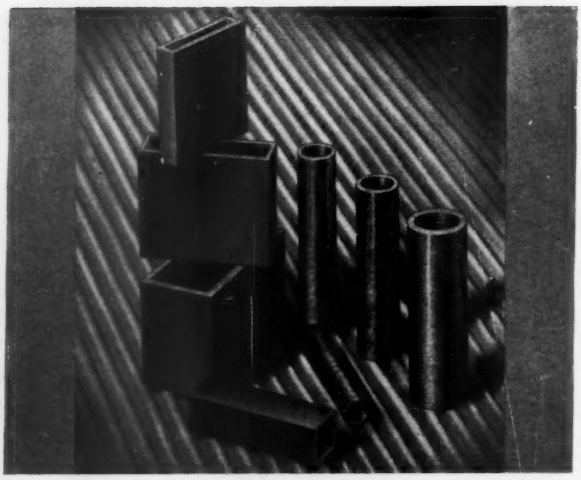
adhere instantly and firmly, strip easily and cleanly

* "Double Bonding" is an *exclusive* Johnson & Johnson process by which the adhesive is permanently bonded to the backing material.

For samples and quotations, please write to

Johnson & Johnson (GT. BRITAIN) LTD. SLOUGH, BUCKS

Manufacturers of Permacel Cellulose Tape, Permacel (Crepe) Paper Tape and Permacel Cloth Tape



"RESOID" INSULATING TUBES

Long experience, before moving to our new factory, is responsible for the high quality of the "Resoid" and micanite tubes we produce. All types and sizes are available, and can be moulded to customers' bars and components when required.

Our complete insulation service also includes mica and micanite parts, heating elements, mouldings, and fabricated parts in "Bakelite" sheet, rod and tube.

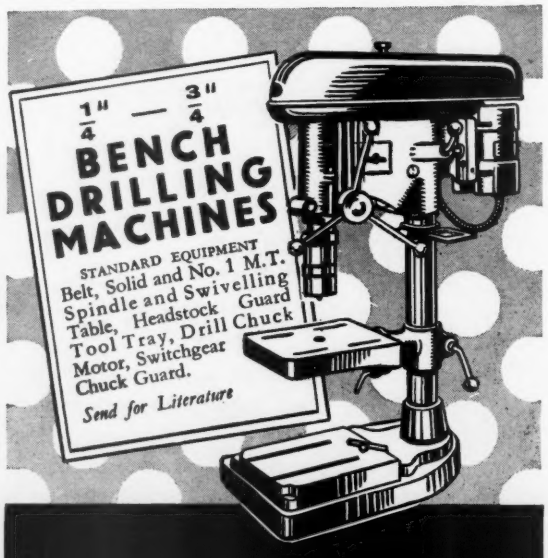
R M P

RESINOID & MICA PRODUCTS LTD.,
Colonial Works, Mary Street, Birmingham, 12

Telephone: CALthorpe 1303

London Office :—28, Queen Anne's Gate, Westminster, S.W.1 Tel : Whitehall 8892

3721C



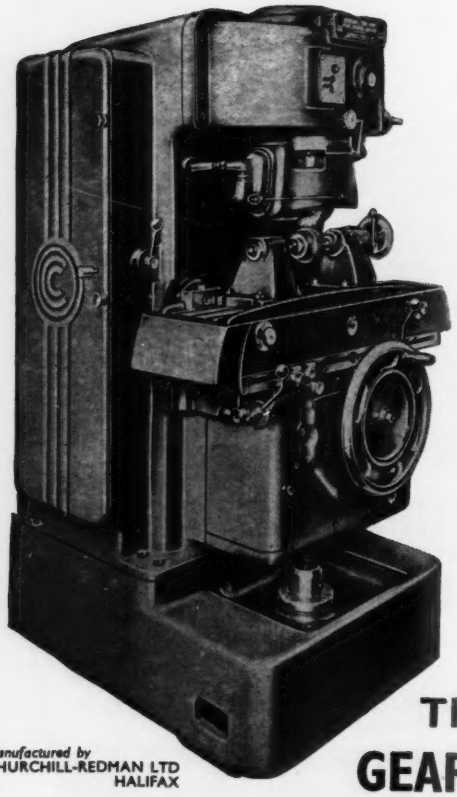
CASHMORES

JOHN CASHMORE LTD. GREAT BRIDGE TIPTON STAFFS

Telephone TIPTON 2181 (5 lines)

also at NEWPORT MON. *Telephone NEWPORT 3944* (4 lines)

CE 317dm



Manufactured by
CHURCHILL-REDMAN LTD
HALIFAX

THE ELLIPTOID TOOTH FORM

. . . . is the answer to some difficult gear problems, and is applicable to both spur and helical gears.

The Elliptoid tooth has both its horizontal section and vertical profile modified, and end thickness is always less than it is at any other point along the tooth, thus providing a perfect safeguard against end bearing.

Much higher tooth loads may be offered to an Elliptoid Tooth, therefore gear weight may be reduced without risk of stress failures.

THE RED RING GEAR SHAVER

CHARLES CHURCHILL & CO. LTD.

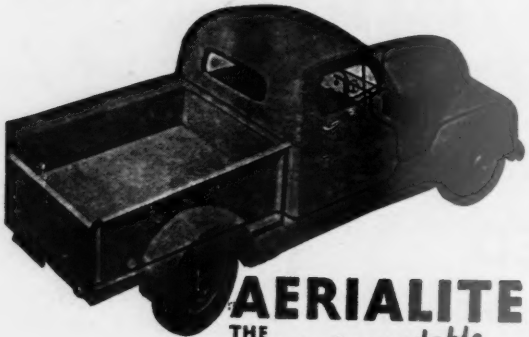
COVENTRY ROAD, SOUTH YARDLEY, BIRMINGHAM

Also at LONDON, MANCHESTER, GLASGOW and NEWCASTLE-ON-TYNE

Ignore this, and it may cost you money!

Faulty ignition, indifferent lighting, inefficient charging, all cause delay and consequent loss of money. At the first sign of any of these danger signals, do the wise thing, have your truck rewired with AERIALITE, the Safe, dependable Auto Cable.

AERIALITE LTD., STALYBRIDGE, Cheshire



AERIALITE
THE *Safe, Dependable* AUTO CABLE

CLASSIFIED ADVERTISEMENTS

RATE 4d. per word, minimum 4/-. Each paragraph charged separately. Box number 5 words—plus 1/-. Advertisements for the January, 1952, issue should be to hand not later than 1st post December 25th. No responsibility accepted for errors.

SITUATIONS VACANT

DRAUGHTSMEN for design and detail and jig work wanted by a large company in the North-West of England making wheel and track type vehicles. Permanencies with good prospects for good men. Give age, experience and salary required to Box 4671 c/o Automobile Engineer. [4465

AUTOMOBILE Draughtsmen required. Men used to engine, transmission or chassis layout preferred. Apply Guy Motors, Ltd., Wolverhampton. [4421

MECHANICAL Engineer required, age about 30/35, by well established company supplying production plant and equipment to the motor car and allied industries. Applicants should have the following qualifications—Public School education, engineering apprenticeship, preferably in the motor car industry and technical training up to A.M.I.Mech.E. standard or equivalent. Successful applicant will be given training relating to advertiser's methods of design, manufacture and installation of their special equipment, with a view to developing into sales engineer. The post, for which a good salary will be paid, is permanent and progressive, entailing travelling throughout the British Isles and occasionally on the Continent. The working conditions are good and a contributory pension scheme is in operation. Please apply in your own handwriting, stating age, full details of education, apprenticeship, technical training, subsequent experience and enclosing copies of testimonials to Box 4939 c/o Automobile Engineer. [4471

DESIGNERS. Ford Motor Company Limited, Dagenham, urgently requires first-class designers of not less than National Certificate standard, with considerable experience of car and truck chassis, engines and tractors, and one vacancy for experienced industrial modeller, used to clay and plaster work. These are established posts. Generous non-contributory Pension Scheme. Reply to Salaried Personnel Department, quoting reference V/RD, giving brief details of qualifications and experience. [4474

DIESEL Service Representative required for Industrial Organization of international repute situated in outer Eastern London area. Applicants should be between 25 and 35 years old, educated at least to School Certificate standard, and have had at least 5 years' experience of diesel engines. National Certificate a strong advantage. Previous experience in consultation work desirable, as duties will include advising users on all problems concerning diesel engines in road and farm vehicles. Successful applicants will spend periods overseas as occasion demands. Full expenses. Starting salary in accordance with qualifications and experience. Generous non-contributory pension scheme. Considerable scope for promotion. Reply to Box 5534, c/o Automobile Engineer, quoting reference F/DR. [4475

DRAUGHTSMAN: Experienced in commercial vehicle design. State wage required and experience. Box A.555, Lee & Nightingale, Liverpool. [4473

DRAUGHTSMEN. Senior and Junior. Experience of press and machine tools, jigs and fixtures, plant, etc., an advantage. Apply stating age, qualifications, experience and salary required. Vandervell Products, Western Ave., W.3. [4482

THE Manufacturers of the Aston Martin and Lagonda cars require senior designer/draughtsmen for their design drawing office. Good salaries for suitable applicants with previous automobile experience. Staff superannuation scheme. Write giving full particulars to the Labour Officer, David Brown Tractors (Engineering) Limited, Hanworth Park, Feltham, Middlesex. [4477

SENIOR and Junior Body Draughtsmen required by the manufacturers of the Lagonda and Aston Martin cars. Previous experience in sheet metal body design desirable. Write giving full particulars to Labour Officer, David Brown Tractors (Engineering) Limited, Hanworth Park, Feltham, Middlesex. [4478

DESIGNER/Section Leader. First-class man required to take charge of section in Birmingham Automobile Accessory Drawing Office, dealing with the production design of component parts. Experience in small mechanisms essential. Knowledge diecastings, mouldings and light press work desirable. Applicants must be capable of negotiating design features with customers and co-ordinating design with production. This is a responsible progressive situation carrying an adequate salary. State full details experience, qualifications and salary. Box 5535 c/o Automobile Engineer. [4479

ASSISTANT Development Engineer required by firm engaged on the manufacture of specialised components for automobile and industrial trades. Good opening with prospects for young man with initiative. Write, stating age, qualifications and salary required. Howard Clayton-Wright Ltd., Wellesbourne, Warwick. [4480

MECHANICAL Engineering Designers required for diesel engine and/or air compressor development. H.N.C. and full works apprenticeship preferred. West London area. Write giving full particulars of age, experience and salary required to Box 5536 c/o Automobile Engineer. [4481

CAPACITY AVAILABLE

DESIGN Capacity offered:

COMPETENT specialist advisory and design service offered on all types of car, truck and coach suspension systems by expert widely experienced in all aspects of vehicle springing. Box 5533 c/o Automobile Engineer. [4473

CELLULOSE

PAINT Spraying Handbook, 3s. 6d. post free. Cellulose and Synthetic Paints and all spraying requisites supplied. Catalogue free. Leonard Brooks, Harold Wood, Romford. [4430

PATENTS

THE Proprietor of British Patent No. 556818, entitled "Brake Control Mechanism," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14, East Jackson Boulevard, Chicago, 4, Illinois, U.S.A. [4472

MACHINERY WANTED

WANTED, all classes of machine tools, also presses and sheet metal working machinery of every description; best prices paid.

F. J. EDWARDS, Ltd., 359-361, Euston Rd., London, N.W.1. Tel. Euston 4681 and 3771. Telegrams: Bescotools, Norwest, London. [3407

INDEX TO MANUFACTURERS' ANNOUNCEMENTS

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "The Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd. Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd. Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.